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A Beginner's Guide to the Stars

Based on

A Beginner's Star Book

by

Kelvin McKready
(Edgar Gardner Murphy)

Arranged by

Maud King Murphy

Second Edition, Revised

With Charts

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A BEGINNER'S GUIDE TO THE STARS

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by
Maud King Murphy

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FOREWORD

THE Star-Maps and Night-Charts which form the nucleus of this Guide are taken from *A Beginner's Star-Book*, by Kelvin McKready; and the text of the Guide is either copied directly from the same source, or selected, condensed and rearranged. In that book, the Sun, Moon, and Planets are discussed more fully, and directions are given for the use of telescopes; and many photographic plates, from originals taken at the great Observatories, illustrate the text.

The aim of this Star-Guide is to eliminate all the more elaborate features of the larger book, and simply to teach the beginner his very first steps in recognizing the stars and planets. It is planned chiefly for use without any optical help, but a few suggestions are added for the use of the opera-glass or field-glass,—instruments which even beginners often have at hand, and which possess the great advantage over telescopes that they can be carried wherever the observer goes.

Except for the Chapter on Learning to Observe, there is no *order* which it is necessary to follow, in reading or studying the Guide. In whatever month the observing begins, there is a Map appropriate to the time, and the directions for the use of the Maps apply equally for all seasons. Cross-references

throughout the pages carry out this plan, so that allusions in a later part of the book can usually be found explained by references given to some earlier page.

But there is a great deal which must be left unexplained; and a beginner in star-gazing may wish to continue his study and learn much more than so small a book can even hint at. The *Beginner's Star-Book*, from which the material for this Guide is drawn, will be the next step for such an observer, and in its pages will be found references to many other and more complete books on Astronomy with which he may carry on his study as far as he chooses.

Meanwhile, to all new beginners, may this Guide serve as a happy introduction.

M. K. M.

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A Beginner's Guide to the Stars

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I

LEARNING TO OBSERVE: FOUR KEY-GROUPS

BEFORE taking up the larger maps the beginner will find it helpful to study the simple outlines of two or three of the smaller groups. The stars that I have chosen are not in all cases complete constellations but conspicuous groups that are easily and quickly identified. By first learning to distinguish these, the task of learning to identify other groups is made easier and simpler. These key-groups become "guide-posts."

They also serve another and more important purpose. Drawing them—as we shall try to do—in closer relation to our actual horizon than is possible with the larger maps, we can perhaps see more clearly just how these star-groups look, not only at their highest apparent altitude, but when they are rising and setting. With the star-groups toward the north, in the neighborhood of the pole, the problem of life-like drawing is quite simple. First of all, therefore, let us study the familiar "Dipper," —sometimes, in England and Canada, called the "Plough," with the help of the diagram on page 6.

LOOKING NORTH—ALL SEASONS

The seven stars which form the "Great Dipper" are *always* in our northern sky. That we do not see them by day is wholly due to the fact that the daylight hides them.

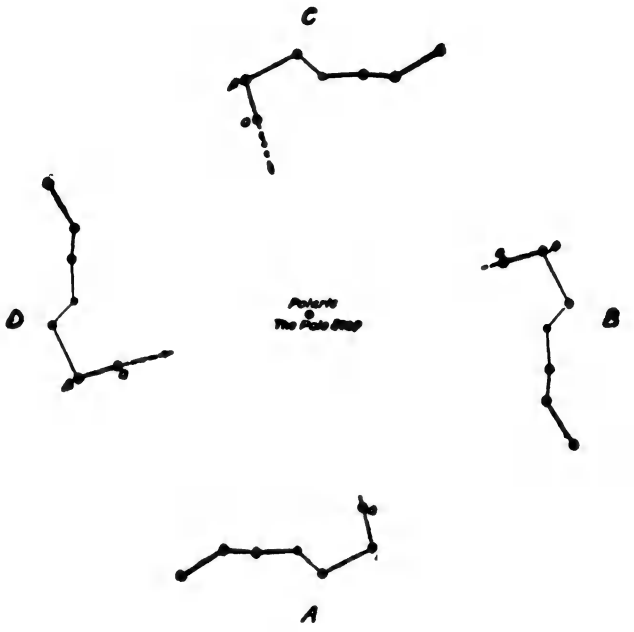
The Sun is so much brighter than any of the stars that, whenever its light is in our sky, the stars are blotted out. But toward the day's close—if the air is clear—we can begin to see the brighter stars, and as the night comes on we find that the stars have been above us and about us all the while. As we watch them we soon see that they, like the Sun, seem to move from east to west; taking about twenty-four hours to complete their round. This —as in the case of the Sun—is, however, only an *apparent* motion. And there is another apparent motion of the stars,—that which brings us the star-changes of the seasons. In each case, that which really moves is, of course, the earth. One of these movements is that of the earth through its orbit round the sun; the other movement—on which we here dwell—is the earth's rotation on its axis.

We know that as we sit in our car in a railway station it will sometimes seem to move when that which moves is not our train at all, but the train just outside. So as our earth turns on its axis once in each twenty-four hours the stars themselves do not revolve, but they do *seem* to revolve within this period of time. The axis on which they seem to turn will thus coincide, of course, with the axis

of the earth—except that this axis will be longer, and its ends will seem to extend outward through the stars to north and south.

Just as the north pole of the earth, for example, is the "top point" of the earth's axis (a point, like the centre of a wheel's hub, which seems not to revolve, but round which the earth turns) so is it with the apparent wheel of the stars. Its central hub is thus at a point in the sky corresponding to the pole of the earth. If we can find this hub we may be sure that at this point there will be no motion of the starry sphere; that round it the other stars will seem to turn; that as we come nearer to it their circles of revolution will grow smaller (just as the circles of revolution in a wheel grow smaller as we look closer to the hub) until, at the pole itself, there will seem to be no motion at all. This will all be clear to us as we watch the movement of the Great Dipper.

Let us assume, for example, that (in any year) on November 20th (a few days earlier or later will make little difference) at about 8 P.M. we are looking at the northern sky. At 8 P.M. on that date the Great Dipper will be found due north in the position marked A. You will see that it is low down, near the horizon, and that the stars marked Beta (β) and Alpha (α) are pointing upward toward a bright star located about midway between the horizon and the zenith (the zenith is the point directly overhead). This star is called "Polaris" or the Pole Star.



FOUR POSITIONS OF THE DIPPER

If you will look northward again in a couple of hours you will see that the Dipper has moved. You will find it passing on its way from position A to position B. You will note, however, that no matter what its position, the stars α and β are still pointing toward the Pole Star. You can see the Dipper advance from position A to position B in about six hours, if you care to maintain your watch

so long. In six hours more you will find it very high up, at position C. It will then pass to position D, and thence to position A again.

And you can see it pass through all these positions without sitting up any later, if you should prefer to look at it—through the course of the year—for a few minutes at about 8 o'clock each night. For on each night the stars complete their round just about four minutes earlier. They are, so to speak, always "four minutes fast." Each night at 8, therefore, after November 20th, the Dipper will be a little farther along than position A, so that at our chosen hour by February 20th the Dipper will be found not at position A but at position B. By May 20th, at about the same hour, we shall find it high overhead at position C. At the same hour, on August 20th, we shall find it at position D; and at about 8 P.M. on November 20th, we shall find that it has completed its circle and is once more at position A. All this will be made much clearer than it can ever be stated in a book if the beginner will take this simple diagram in his hands, turn to the north, and put real eyes on the real stars for one or two consecutive evenings.

But, whether we really observe a little or read a little or do a little of both, there are four facts that will soon be quite clear. We shall note, first, that the stars are in apparent revolution about a central pole; secondly, that the stars in the Dipper marked Beta (β) and Alpha (α)—called the "Pointers"—are always pointing in the general direction

of this pole; thirdly, that the star Polaris—alone among the stars—seems not to move; and fourthly, that the polar-point around which the stars revolve must therefore be at, or very near, this star.

The fact is, of course, that the pole is not exactly at the star Polaris. Polaris, however, is so near to it that it may fairly be called the Pole Star and, if we could place ourselves precisely at our north pole, Polaris would seem to stand almost directly overhead, like a tiny celestial capstone to the projected axis of our earth.

While, therefore, this star also revolves about the pole—the exact pole of the heavens being of course only an imaginary point—yet, because Polaris is so very near the pole, the circle which it makes, as it revolves, is quite small—so small that, for all ordinary purposes, the star seems to stand still. A star placed, however, a little farther from the polar-hub will, as the great wheel revolves, make a larger circle; and the farther from the pole we look—among our northward stars—the larger will be the circles of revolution. Of the two Pointers, Beta (β), of course, will mark a greater circle as it revolves than the star Alpha (α). And yet all the stars of our sky that are no farther from the polar-hub than the outermost star of the Dipper, can describe their circles of revolution without being carried below our horizon. They are always, therefore, in our northern skies.

The stars, however, that are placed somewhat farther from the polar-hub will necessarily, as the

wheel turns, dip below the horizon for a longer or shorter period; and the farther they are from the pole the longer must they be below our horizon and absent from our skies. These stars, as our earth turns on its axis, will seem therefore to rise and set. Moreover, as we come to study them we shall see that our figure of speech must be changed. For as we face the north and look at Polaris we are gazing not strictly at the hub of a flat wheel, but—as we have said—toward the pole of a hollow sphere, its apparent axis the projection of the earth's axis, and its equator the projection of our own equator. We may therefore imagine the spokes of the revolving wheel—as they extend—gradually bending inward toward us, and forming the ribs of a vast including globe. We stand—inclosed as it were—at the sphere's centre.

The circumpolar stars turn with the sphere itself, but as they lie so near the pole, the circle of their revolution never carries them out of sight. Sometimes, as we face the north, we find the Dipper above the Pole Star, sometimes below it; sometimes it is a little to our right, slowly climbing upward as in position B. Sometimes it is a little to our left, with the bowl turned downward as in position D, but it is always before us in our northern sky. Yet with the sphere's turning, the stars *farther* from the pole, like bright points fixed on the inner surface of its concave sides—as these arch themselves above and below the horizon—appear and disappear according to their hours and their

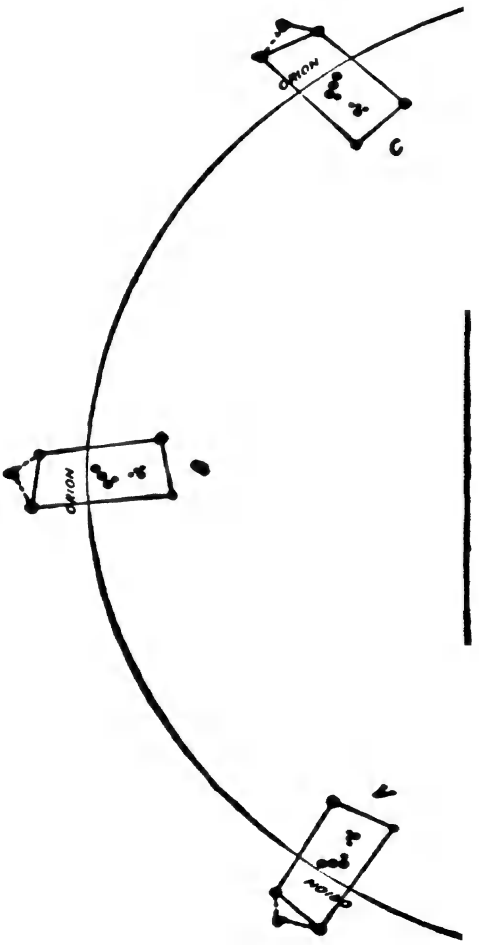
seasons. Let us make this still clearer by turning to another of our key-groups.

LOOKING SOUTH—NOVEMBER TO APRIL

We are now to look at a star-group quite far from the pole. So wide is the circle which it makes in its daily revolution that its stars not only dip below the horizon, but are really above it for only about 10 hours in the 24. As it is so far from the pole we will face now towards the south. On the same evening, November 20th, let us first realize as we face southwards that we have put the pole at our backs. The east, therefore, will be now at our left; the west will be at our right. At 8 P.M. on November 20th, the stars of Orion, perhaps the most beautiful of the constellations, begin to appear low down in the eastern sky.

By 9 o'clock these stars will probably be clear of the mists that in Autumn so often lie at "the edge of the world"; and by 9:30 or 10 they will be well placed for observation. This group is now, let us assume, at position A, with the three bright stars that pass diagonally through the great square, pointing upward; by 1:30 A.M. it will reach position B; by 5 A.M. it will reach position C; by 8 A.M. it will have set.

Most of us, however, do not care to watch through a whole night, even to follow the march of such a constellation as Orion. We will prefer to follow the other method. Remembering that the stars rise each evening four minutes earlier than on



THREE POSITIONS OF ORION

the evening before, we can just as well follow Orion through his march across the sky by looking for him through the hours of the early evening at successive dates. We shall need more time than one night or one week or one month. As Orion comes to position A four minutes earlier each night, so it will be four minutes earlier each night when he reaches position B; and by 8 P.M. in January we shall find these stars nearer to B than to A. At 8 in February they will be quite at B, and by 8 P.M. in April they will be at C. We shall thus have almost six months in which we shall find Orion conveniently placed for observation among the stars of the early evening.

This little diagram is placed at this point, however, not only in order that we may follow the course of one star-group, but in order that we may also get some idea as to how Orion looks as he rises and sets. The impression given in the diagram is not perfect. I have already explained that—inasmuch as the stars are not arranged on four straight walls but seem to dot the inner surface of a hollow sphere—it is impossible to map them perfectly on a flat surface like the page of a book. But through such a diagram as we have just made, we can help to bring to ourselves a clearer picture of some of the positions of the star-groups that make the circles of their revolution far out from the pole. We can see how they slant, or tip, as they rise and set.

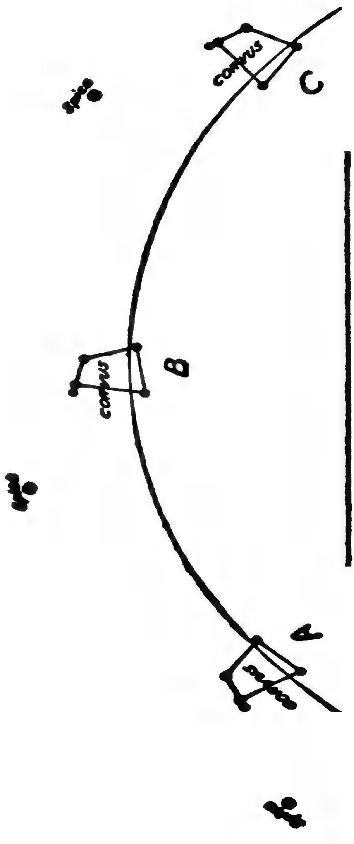
If we attempted in our larger maps to show this slant or tip for every group we should have to

make a globe. We could not do it well on paper without involving ourselves in more technical and practical difficulties than the beginner would care to try to understand. This slant or tip of some of the constellations is, on the other hand, very quickly understood in the light of a little actual observation. Moreover, many of the star-groups show little if any distortion in the maps; and as we look farther from the equator and nearer to the poles north or south we find it less conspicuous. Let us take, therefore, another group. It is Corvus, the Crow (or the Raven); and near it we will place the bright star Spica (pronounced Spī′-ka).

LOOKING SOUTH—APRIL TO AUGUST

The stars of this little group are not especially bright, but the outline which they present is clear and simple. It will give us additional light on the lessons already suggested, and we may gain from it at least two other helpful points.

Corvus rises at the southeast, shortly before the time when we find Orion setting at the west. On April 1st at 8 P.M. we shall find it a little above the horizon at the position marked A. If we follow it through its whole course in a single night, we shall find that by 11:15 P.M., Corvus has advanced to position B and by 3 A.M. to position C,—setting about 4 A.M. Or, as we have already explained in relation to Orion, we can follow its march across the sky by keeping an occasional look-out for it, from week to week, in the skies of the early even-



THREE POSITIONS OF CORVUS WITH SPICA

ing. While at 8 P.M. on April 1st it will be found near position A, it may be observed—at the same hour—at position B on May 20th, and at position C, by the 20th of July, unless the long daylight of July should then prevent our seeing it.

You will note, however, how constantly the bright star Spica follows it—how closely, in fact, Spica is associated with it in all the positions through which it moves. You will see, therefore, not only how Corvus helps us to find and identify Spica, but how Spica—one of the brightest stars of the sky—will always help us to find Corvus under all sorts of difficult conditions of light and air. Spica does not belong to Corvus; it belongs to another constellation; yet just as one neighbor's house may help us to find another, so—in finding our way about the sky—there is much good use for neighbor-stars.

The association of Corvus and Spica in our little diagram will serve, therefore, as an illustration of a method, the method of learning the stars and of finding our way about the sky by the reference of stars and groups to one another. As the "fixed" stars are not wandering about in our heavens but have retained for ages their relative positions in the sky, the practice of connecting them mentally with simple lines of direction becomes full of interest and value. When, for example, your attention is once called to the fact that a short line from the two upper stars in Corvus will always go straight through Spica, the association thus suggested is not

likely to be forgotten. In the same way, we have connected the Pointers in the Dipper with the Pole Star and we shall also see when we come to study Orion more closely that the row of three bright stars running diagonally through the centre will always point in one direction towards the superb white star Sirius and in the other direction toward the reddish star Aldebaran.

LOOKING SOUTH—JUNE TO NOVEMBER

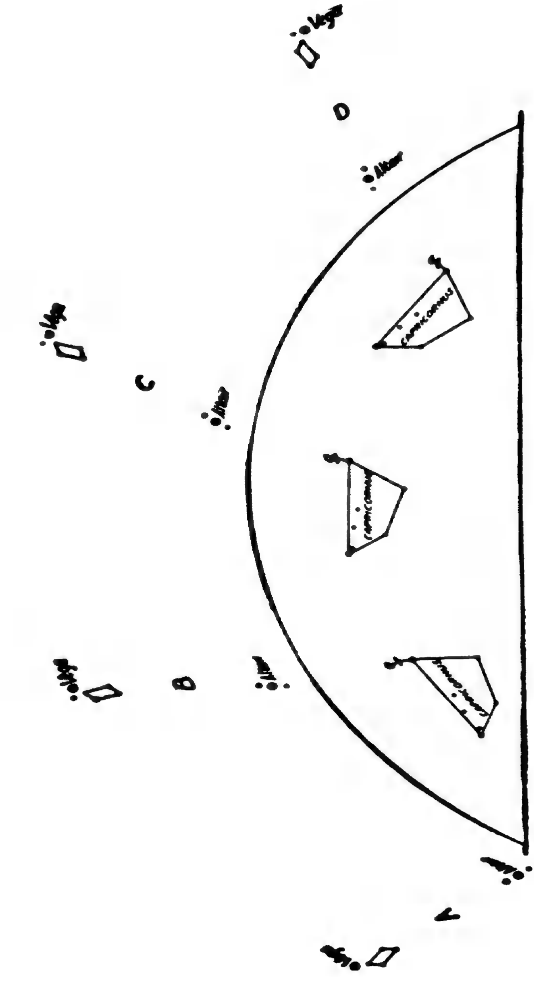
The star-groups at which we have been looking have been so plain in outline, and the relations they suggest have been so evident that I now prefer, in closing the series, to take something a little more difficult. As the month of June begins we shall find at 9 P.M. as we face southward that the bright star Altair and its two companions are rising on the left. As the stars rise higher and as the mists along the eastern horizon are left behind, they form a small but striking group. The lowest star is not so bright as either of its companions, and yet—if the night be clear—these three almost equidistant points of light form one of the finest landmarks of the summer sky.

By 9 P.M. on June 1st we shall find Altair at position A; at position B by 12:30 A.M.; at C by 4 A.M.; at D by 7 A.M., though lost in daylight. Or, preferring to watch it marching through the months rather than through all hours of a single night, we may observe it during the early evenings of June at position A, during the early evenings of July

and August as it advances from A to B; and during the early evenings of September, October, and November from B to C and from C to D.

But there are two other groups in the sky, through practically the same hours, to which I would now call your attention. Altair and its two companions point—like a straight sign-post—in two directions. As they point upward we shall find them guiding us in the general direction of Vega, the white splendid star of the constellation Lyra. It is distant from Altair about twice as far as the distance between Corvus and Spica (now southwest as Altair rises) or thirty degrees. As Altair moves toward position B, Vega also will be found so much higher in the sky that, as we continue to face south, we shall have to undergo some discomfort in looking up at it. But toward this brighter star, Altair still makes, with its two companions, the same shining pointer from every position and at every hour.

And this pointer directs us downward as well as upward. By the time Altair reaches position B, we shall see—by looking closely—that there is below it at a distance of a little over 20 degrees a dim group of rather small stars,—the constellation Capricornus. It is called the Sea-goat, but it looks as little like a goat as Corvus looks like a Raven. Just because its stars are not bright and its outline faint, we shall find the direction given us by Altair and its companions all the more helpful. Indeed, it is always well, whenever possible, to make the



FOUR POSITIONS OF ALTAIR

brighter groups of stars serve as guides to groups that are more obscure. For the obscure groups often possess interesting features even to the beginner. Capricornus, for example, is one of the constellations through which the planets take their way in their march across the sky (see p. 77). It is also interesting to note that the star marked Alpha (α) may at first seem to the observer to be single; but even an opera-glass will show that it is double, and that still another star is not far distant.

Here, however,—as with the other key-groups—I have called attention to the group, not for the purpose of setting forth this or that detail, but in order to illustrate the different aspects of certain star-groups in their different positions We learn, too, how to use one group to help us find another; to make for ourselves paths in the sky by which to find our way about; until the whole sky on any starry night is as familiar to us as our own home.

II

THE USE OF THE CHARTS AND MAPS

In the Charts which follow, on the left-hand pages from page 28 to page 51, the stars visible in the night sky are represented in their successive positions as they make their yearly round (see p. 7). Each map is repeated on the opposite page, with its black and white reversed, and with the addition of names for the Constellations and for some of the stars, as well as a few lines here and there to help the eye in following the outlines of groups. It will be very easy to identify and name the stars in the black chart, by comparison with the white map, but it will perhaps be more difficult to identify the stars in the sky with the stars in the book. The suggestions given in the previous chapter will help you, in a general way; the aim of this chapter is to consider step by step the practical relations of the maps to the sky.

Remember first and always that the accurate representation of the hollow bowl of the sky on a flat map is as impossible as the representation of any large part of the surface of the round earth in the same way. The centre of either map can be pretty accurate, but the edges must be distorted, *spreading* the hills and streams and cities, or stars,

farther apart than they really should be shown. So I repeat many times the injunction to "begin at the centre of the map"; after the central groups of any map are learned, the border groups will become simpler to identify.

The presence of the "Great Dipper," always in the sky, makes the northern groups easier to study than the southern. On any clear night, in winter or summer, you may make yourself familiar with the region about the North Pole of the Heavens. The southern groups come in their turns to the night sky, and then, as explained on p. 9 are *not* to be seen for long periods, but if you follow the time-schedule below the maps, you will see what the southern sky has to show on any given evening.

In the white maps, the names of the Constellations are given in Latin, since it is by their Latin names that they are called in all catalogues. Some of the Latin names are translations into Latin from a still earlier Greek. Where the name is that of a person, you may find the story connected with him or her in any Classical Dictionary; where the name has an English equivalent, it is given in the list of Constellations, Chapter V. The Constellations have been known by these names so long that it would be impossible to change the usage, but you will see at once that there is no fitness in most of the names, and will wonder how the stars ever came to be grouped in just this way. To that question I think there is no answer. The boundaries of the Constellations (which are not indicated

celestial maps. There are no natural boundaries in the sky, and we must find means to describe each star briefly in such a way as to show with certainty which one is meant. A few bright stars have names of their own by which they have been known for long centuries (and which often show their Arabian origin), but for less conspicuous stars, the method has been first this rough grouping into constellations, and then the naming of the stars inside each constellation. For these star-names the letters of the Greek Alphabet are used, as far as they go. (You will find them on page 60.) Every constellation has its Alpha (α), which is usually its brightest star, and very often has besides a special name of its own; as for instance, the Alpha (α) of Orion is Betelgeuze, and that of Leo is Regulus. To less brilliant stars are assigned the other letters, going down the alphabet, without strict adherence to order. The map-makers have to use still other names for the fainter stars, but that does not concern us here.

The "magnitude" or relative brilliancy of the stars shown in the maps is roughly indicated by the size of the dot standing for each one. The legend in the lower left corner of the key-maps explains this further. No stars are shown fainter than the sixth magnitude, since even a very good eye could hardly detect a fainter one. Stars are not bright

to us in proportion to their real brilliancy, because they are at such very various distances from us. Even the nearest fixed star is more than 25,000,000,000 miles away from us and the farthest are many times more distant, so far that their light takes thousands of years to reach us. So we do not try to classify them by their real brightness, but by their brightness as seen by us. First-magnitude stars are the brightest. There are 20 of them, of which 16 are visible in our latitude, and are shown in our maps. Sirius is the brightest of all. The faintest of the first-magnitude stars is only a little brighter than the brightest of the second magnitude and so on down the scale.

One more character which appears on the key-maps must be explained. The little circles with numerals preceded by the letter M mark the places of star-clusters or of nebulæ. When Messier (for whose name the letter stands) was making his list, the distinction was not clear between nebulæ and clusters, and he listed them together. For the purposes of these simple maps his classification serves well enough; and the little circle with Messier's number shows that you have not a star to observe, but a "misty" spot, which your naked eye may see, but which will probably call for an opera-glass; and which the glass may show as a cluster of stars or may leave still misty and nebulous.

The *planets* are constantly changing their positions among the stars, so they cannot be given

The Night-Charts and Key-Maps are thus strictly confined to the *stars proper*. Here are shown their relations to each other and their approximate positions for a period of years. Each map has its time-table; and, as you will see, the maps given represent the sky at intervals of four hours. The lower border of each map corresponds to the horizon of the observer in the latitude of New York or Chicago. Observers as far north as London will see at the horizon a little less of the southern sky; those as far south as Richmond will see at the horizon a little less of the sky to the northward. But only with very clear air and an unobstructed view, will the lowest stars of the maps be visible.

The upper border of each map corresponds at the centre with the sky *overhead*. The stars here are too high for convenient observation; and stars at rising or at setting are often obscured by mists. So the notes in Chapter IV are chiefly concerned with

those stars or groups that are well placed for observation at the time covered by the chart mentioned in each case. As all groups come repeatedly to the sky, each one will have its favorable times for study. The maps for north and south cover much of the east and west also, presenting together the whole sky. But remember again that in the representation of the hollow sphere of the sky on a flat surface there must be distortion, greatest at the edges, and the star-groups to your east and west as you observe will not be so recognizable on the map, as those in the north and south. In time you will adjust yourself to the situation; *at first* always study the centre of the map.

The direction of the apparent movement of the stars from east to west, is suggested by the arrows in the upper corners of the maps; in the southward maps these arrows may be taken to suggest also the slant or inclination of the constellation lines as the groups rise and set, and so to correct somewhat the necessary distortion. This apparent slant or inclination is more clearly set forth on page 12, where we see that Orion and Corvus, for example, do not march straight across the sky as though it were a blackboard, but that they follow great curves through the sky's vault. And what is true of these groups is true of all.

III

STAR-MAPS FOR ALL SEASONS

THE time-interval between each two successive maps in this chapter is four hours; or, considered in another way, it is two months. The stars complete each daily round in about four minutes less than twenty-four hours, so in sixty days, or two months, they will have advanced four hours, in comparison with sun-time. In a whole year of twelve months, their advance carries them six times as far as in the two-month period, or six times as far as they seem to move in four hours of one evening. So the recurrence of the same day and hour each year brings them regularly to the same position in our sky. This explains the legends below the maps, which name the days and hour for which each map is drawn. A difference of two months, as from November 1 to January 1 (p. 29), corresponds to a difference of four hours by the clock; a difference of one month, to two hours; of fifteen days or half a month, to one hour.

If this seems complicated, told in words, it will simplify itself as you observe the changes described.

You will see that these figures would be *exact*, only if all months were of the same length, thirty days, and the year exactly 360 days. But the variation is so small that we need not regard it.

The legends below the maps are concerned only with the hours of the evening; the maps for early morning hours can easily be found by remembering the difference of time by which they are regularly separated. For instance, the maps for May 1st, at midnight, are found on pages 40–43; the best maps for 4 A.M. on May 2d, four hours later, would therefore be those that follow next in the book, on pages 44–47. These morning hours are excellent times for observation.

In *all* the charts of the northern sky, you will find the Great Dipper; see p. 6.

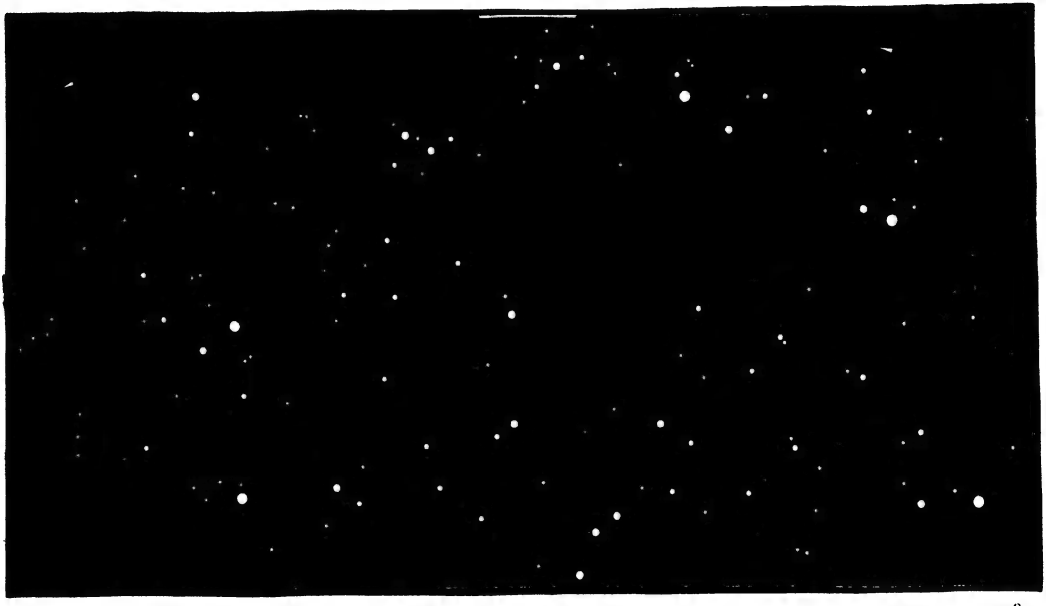
In the southern charts for winter evenings (Nos. 2 and 4) you will find the three bright stars of Orion's belt, pointing in one direction toward Sirius, and in the other toward Aldebaran; see p. 12.

In the southern charts for summer evenings (Nos. 6 and 8) you will find the Constellation Corvus and the bright star Spica; see p. 14.

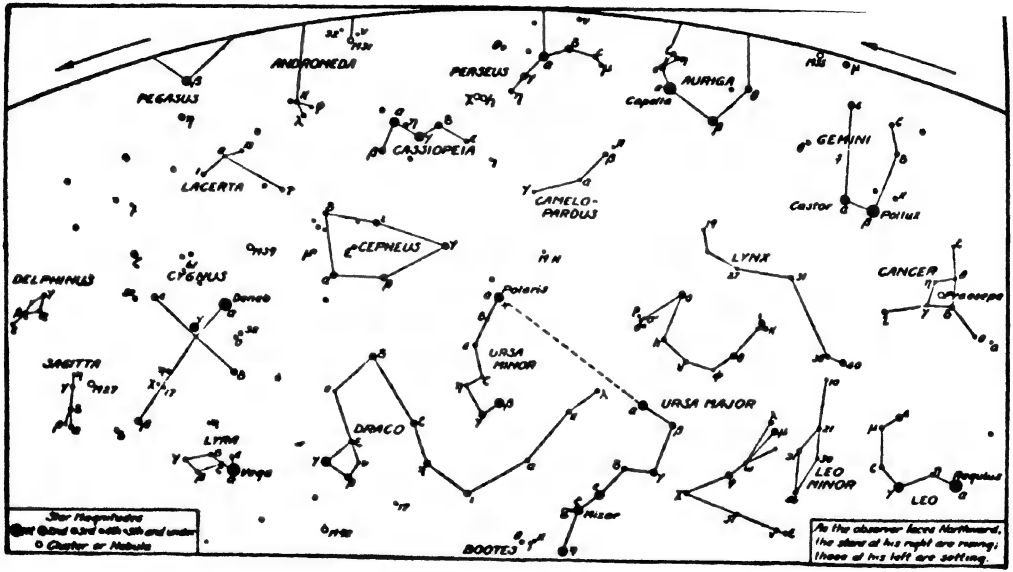
In the southern charts for autumn evenings (Nos. 9 and 10) you will find the "Shaft of Altair" pointing to Capricornus on the one side and to Lyra on the other; see p. 18.

The chapter on Learning to Observe uses the movements of these groups to explain the movements of all stars. A reading of that chapter will help in the use of the maps.

NIGHT-CHART I



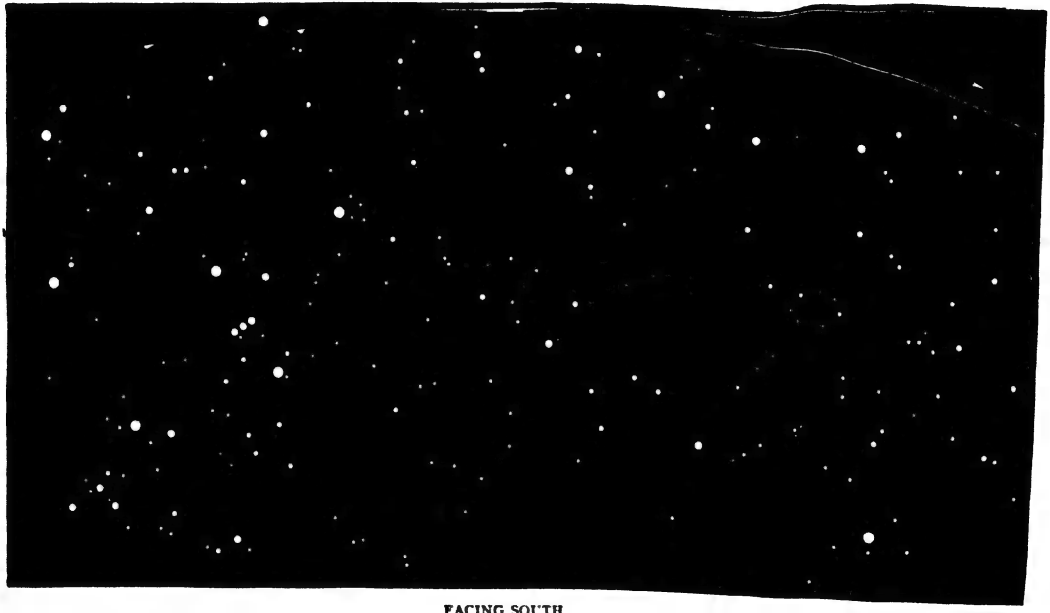
FACING NORTH



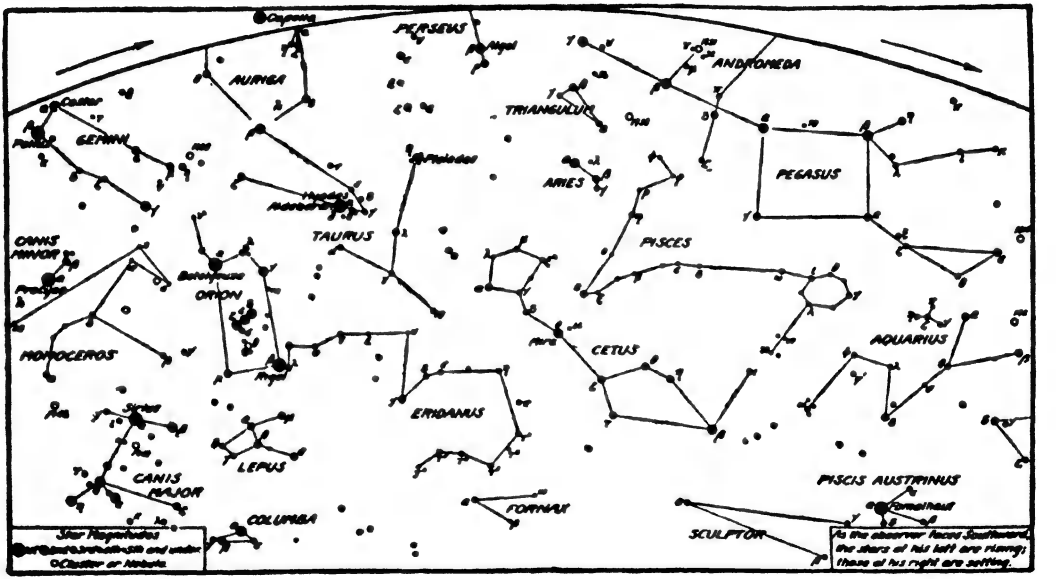
FACING NORTH

IAN. 1. 8 P.M., DEC. 15, 9 P.M., DEC. 1, 10 P.M., NOV. 15, 11 P.M., NOV. 1, 12 P.M.

NIGHT-CHART 2



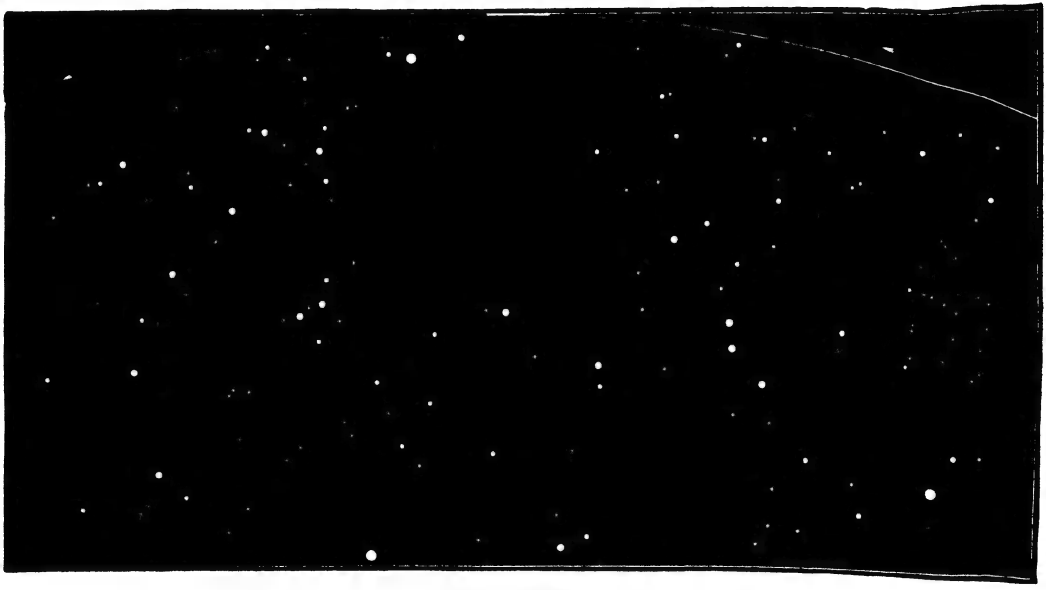
FACING SOUTH



FACING SOUTH

JAN. 1, 8 P.M., DEC. 15, 9 P.M., DEC. 1, 10 P.M., NOV. 15, 11 P.M., NOV. 1, 12 P.M.

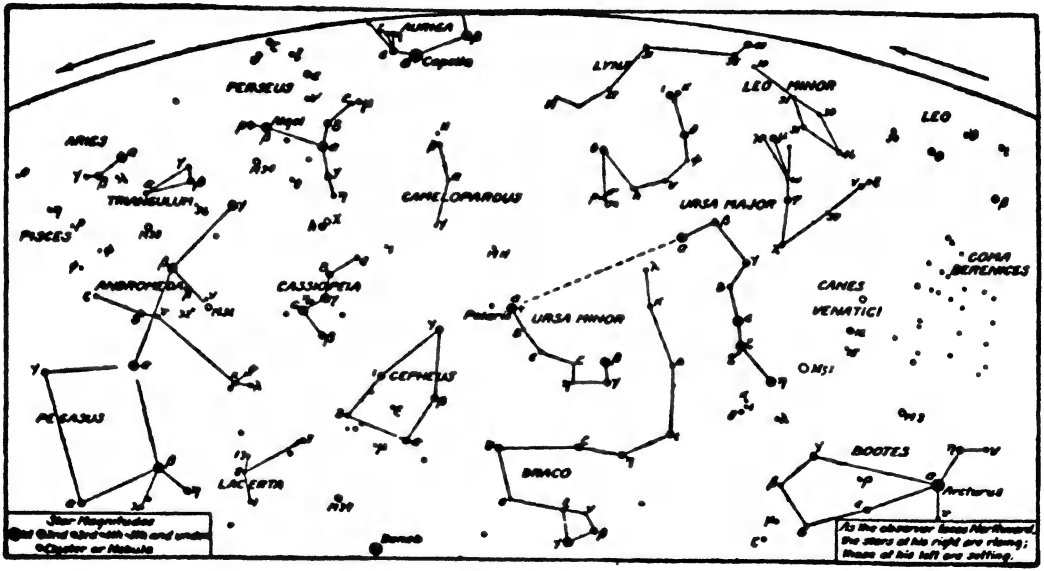
NIGHT-CHART 8



FACING NORTH

MARCH 1, 8 P.M., FEB. 15, 9 P.M., FEB. 1, 10 P.M., JAN. 15, 11 P.M., JAN. 1, 12 P.M.

KEY-MAP 3



FACING NORTH

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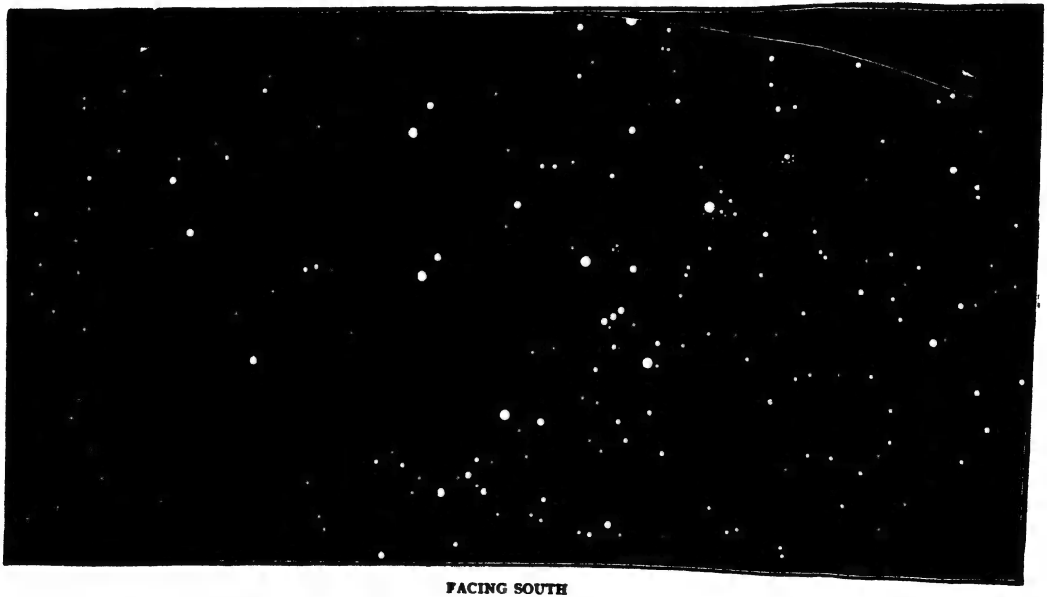
MARCH 1, 8 P.M., FEB. 15, 9 P.M., FEB. 1, 10 P.M., JAN. 15, 11 P.M., JAN. 1, 12 P.M.

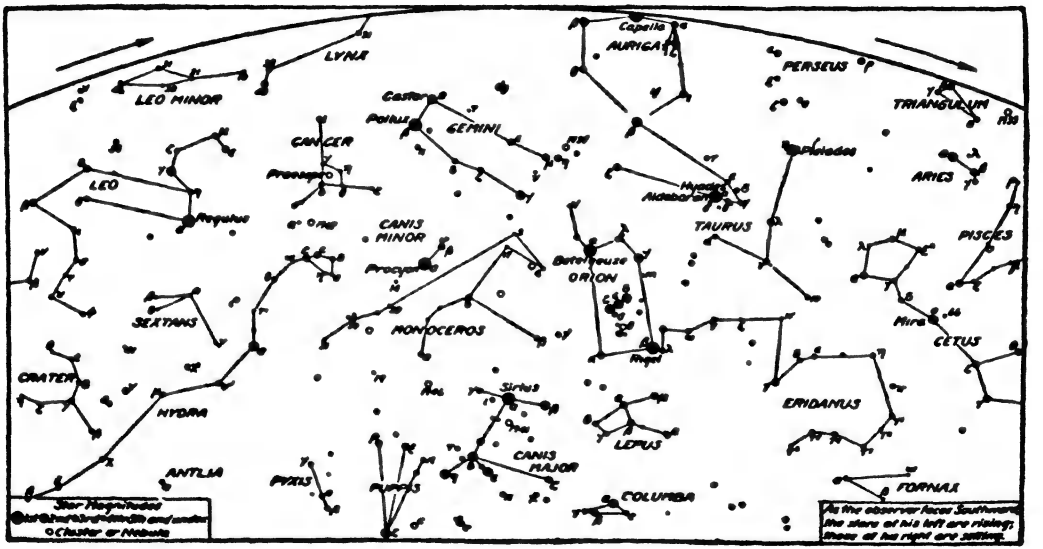
NIGHT-CHART 4



FACING SOUTH

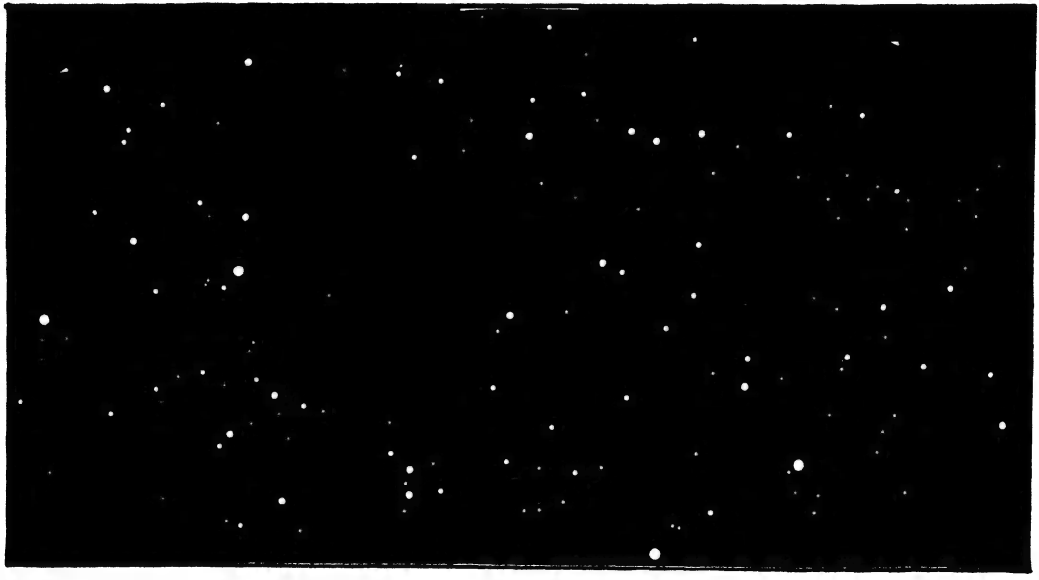
MARCH 1, 8 P.M., FEB. 15, 9 P.M., FEB. 1, 10 P.M., JAN. 15, 11 P.M., JAN. 1, 12 P.M.

KEY-MAP 4



FACING SOUTH

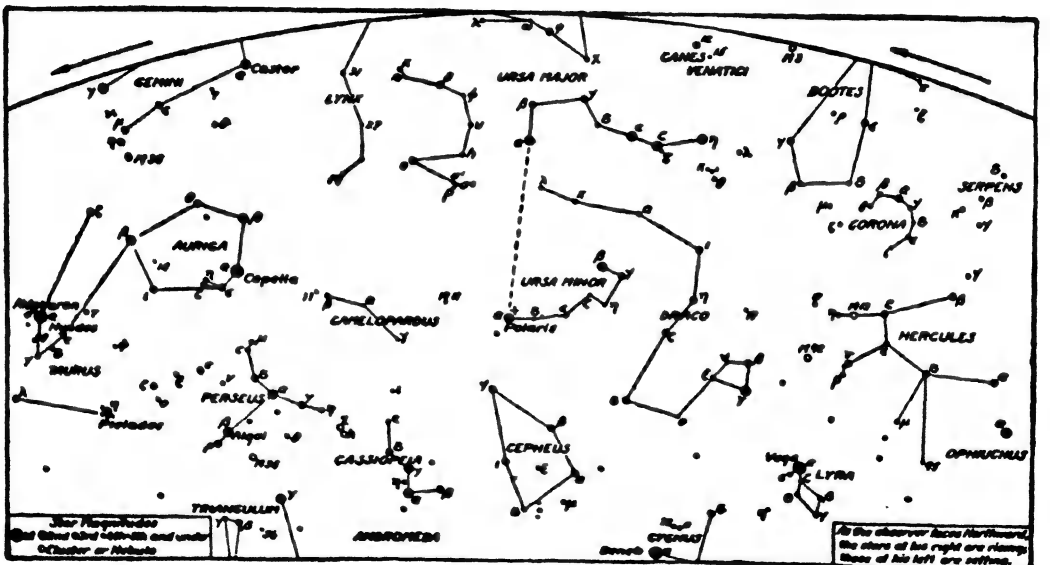
MARCH 1, 8 P.M., FEB. 15, 9 P.M., FEB. 1, 10 P.M., JAN. 15, 11 P.M., JAN. 1, 12 P.M.



FACING NORTH

MAY 1, 8 P.M., APRIL 15, 9 P.M., APRIL 1, 10 P.M., MARCH 15, 11 P.M., MARCH 1, 12 P.M.

KEY-MAP 5

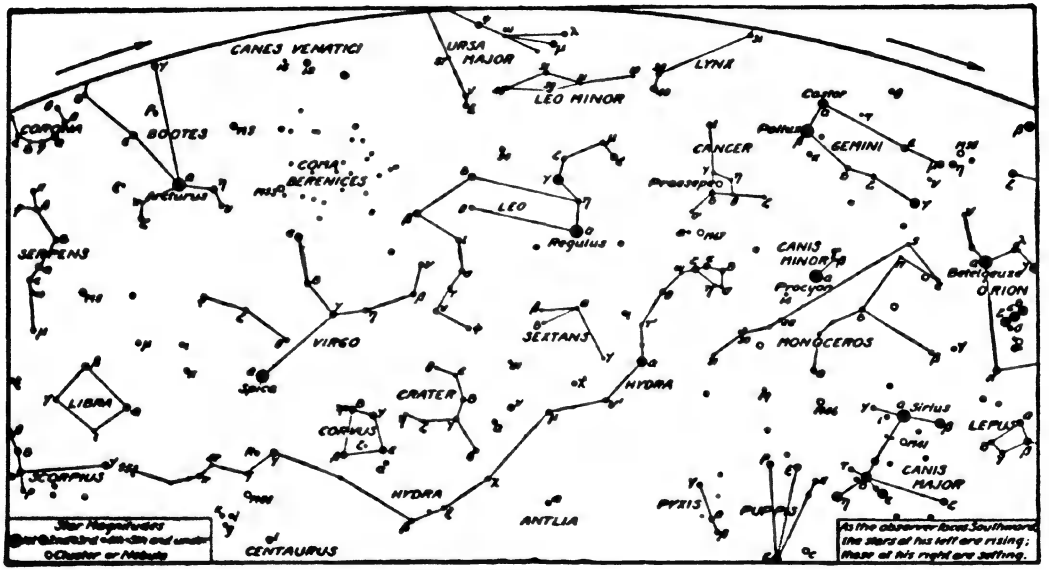


FACING NORTH

MAY 1 8 P.M., APRIL 15, 9 P.M., APRIL 1, 10 P.M., MARCH 15, 11 P.M., MARCH 1, 12 P.M.

FACING SOUTH.

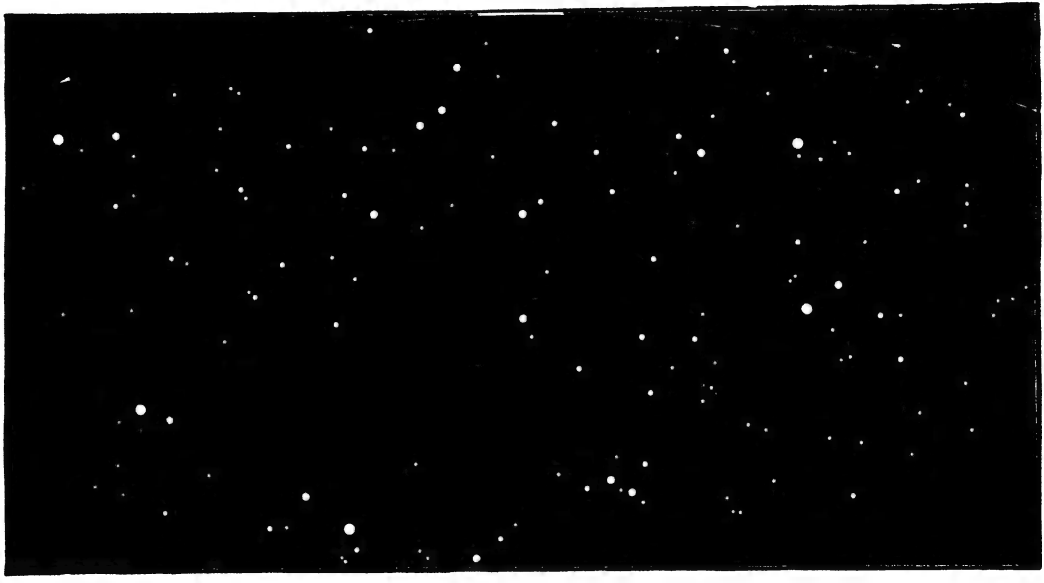
MAY 1, 8 P.M., APRIL 15, 9 P.M., APRIL 1, 10 P.M., MARCH 15, 11 P.M., MARCH 1, 12 P.M.



FACING SOUTH.

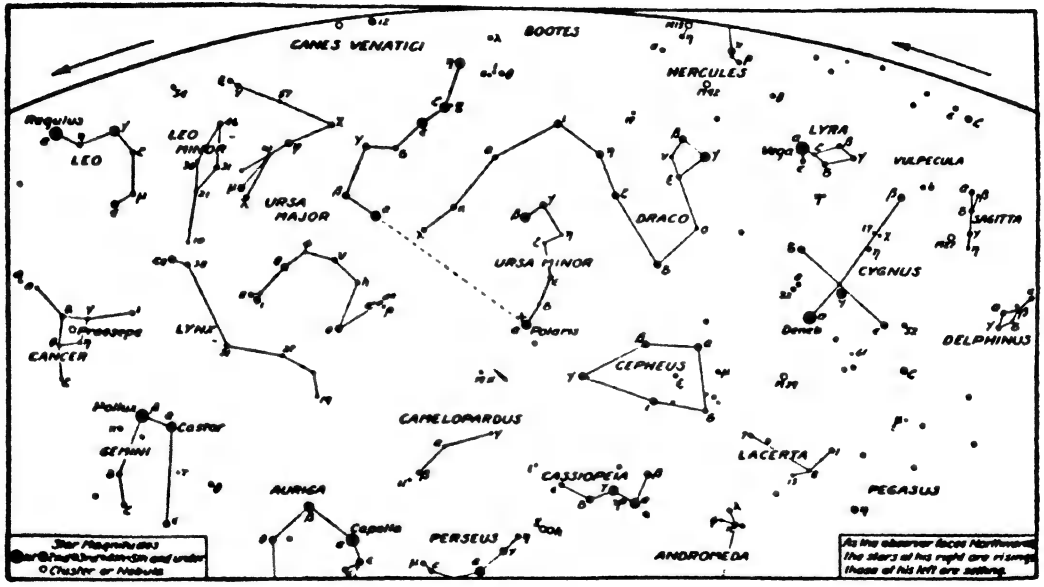
MAY 1, 8 P.M., APRIL 15, 9 P.M., APRIL 1, 10 P.M., MARCH 15, 11 P.M., MARCH 1, 12 P.M.

NIGHT-CHART 7



FACING NORTH

JULY 1, 8 P.M., JUNE 15, 9 P.M., JUNE 1, 10 P.M., MAY 15, 11 P.M., MAY 1, 12 P.M.



FACING NORTH.

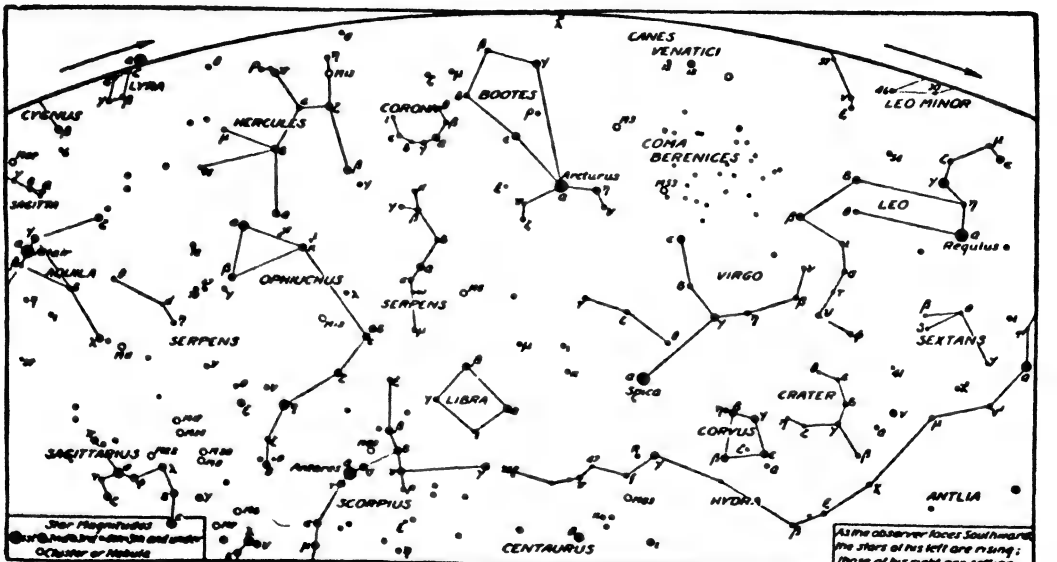
JULY 1, 8 P.M., JUNE 15, 10 P.M., JUNE 1, 10 P.M., MAY 15, 11 P.M., MAY 1, 12 P.M.

NIGHT-CHART 8

FACING SOUTH

JULY 1, 8 P.M., JUNE 15, 9 P.M., JUNE 1, 10 P.M., MAY 15, 11 P.M., MAY 1, 12 P.M.

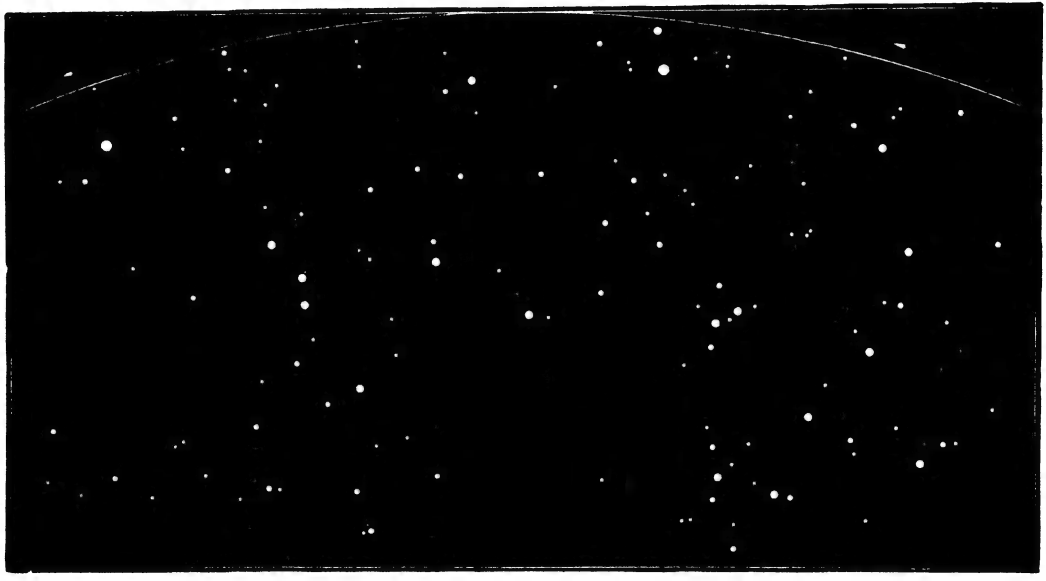
KEY-MAP 8



FACING SOUTH

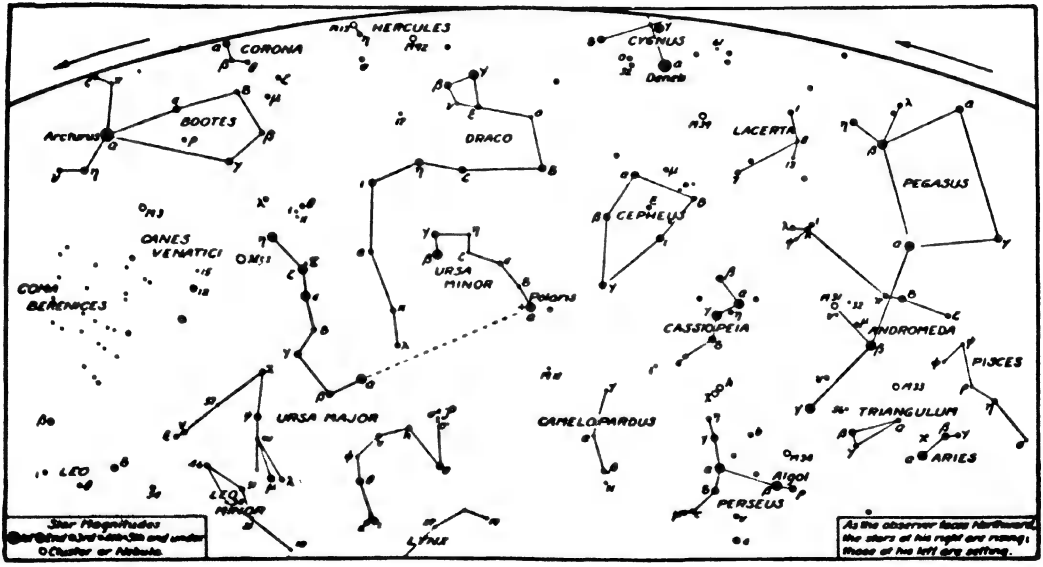
JULY 1, 8 P.M., JUNE 15, 9 P.M., JUNE 1, 10 P.M., MAY 15, 11 P.M., MAY 1, 12 P.M.

NIGHT-CHART 9



FACING NORTH

SEPT. 1, 8 P.M., AUG. 15, 9 P.M., AUG. 1, 10 P.M., JULY 15, 11 P.M., JULY 1, 12 P.M.



FACING NORTH

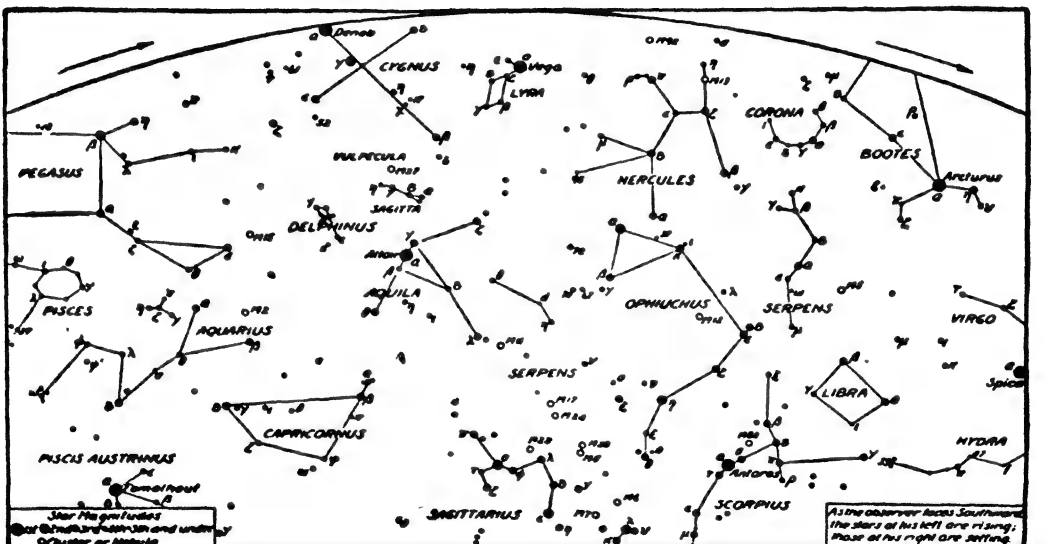
SEPT. 1, 8 P.M., AUG. 15, 9 P.M., AUG. 1, 10 P.M., JULY 15, 11 P.M., JULY 1, 12 P.M.

NIGHT-CHART 10

FACING SOUTH

SEPT. 1, 8 P.M., AUG. 15, 9 P.M., AUG. 1, 10 P.M., JULY 15, 11 P.M., JULY 1, 12 P.M.

KEY-MAP TO



FACING SOUTH

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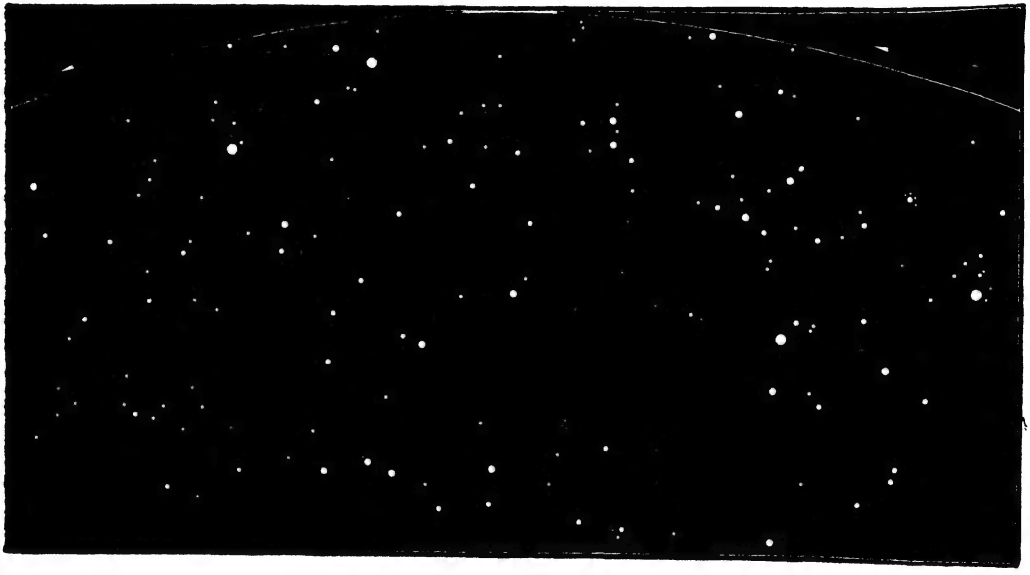
SEPT. 1, 8 P.M., AUG. 15, 9 P.M., AUG. 1, 10 P.M., JULY 15, 11 P.M., JULY 1, 12 P.M.

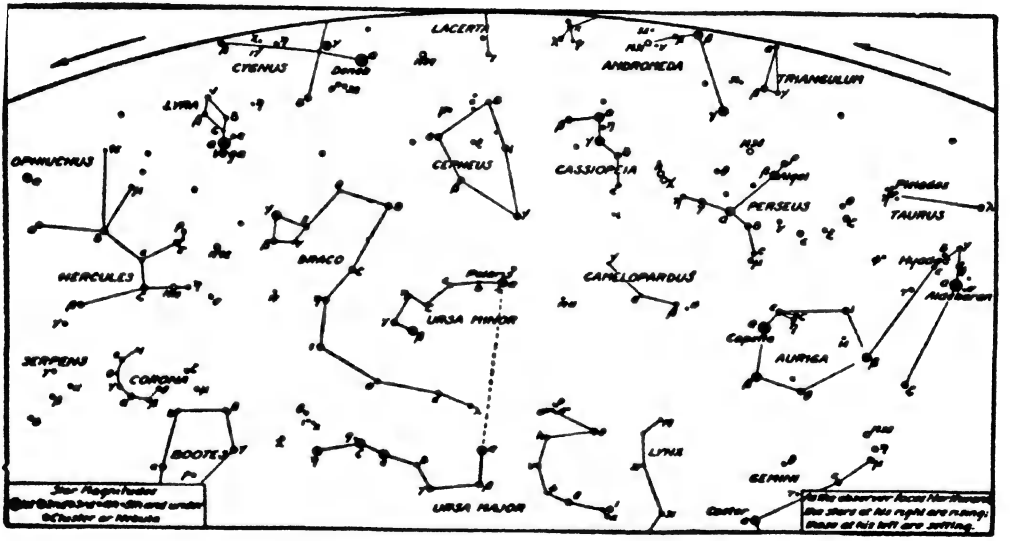
NIGHT-CHART II



FACING NORTH

NOV. 1, 8 P.M., OCT. 15, 9 P.M., OCT. 1, 10 P.M., SEPT. 15, 11 P.M., SEPT. 1, 12 P.M.

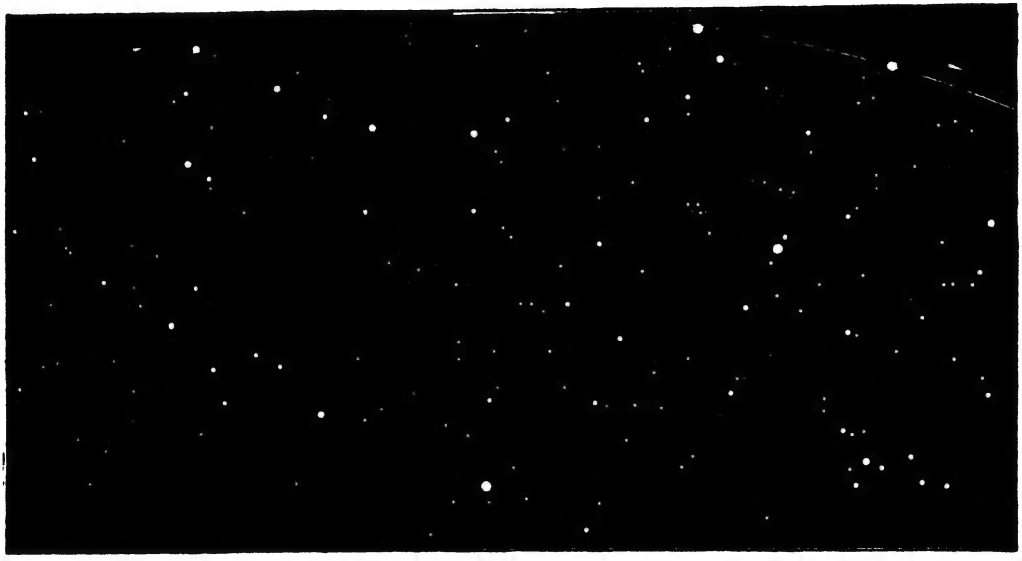
KEY-MAP II



FACING NORTH

NOV. 1, 8 P.M., OCT. 15, 9 P.M., OCT. 1, 10 P.M., SEPT. 15, 11 P.M., SEPT. 1, 12 P.M.

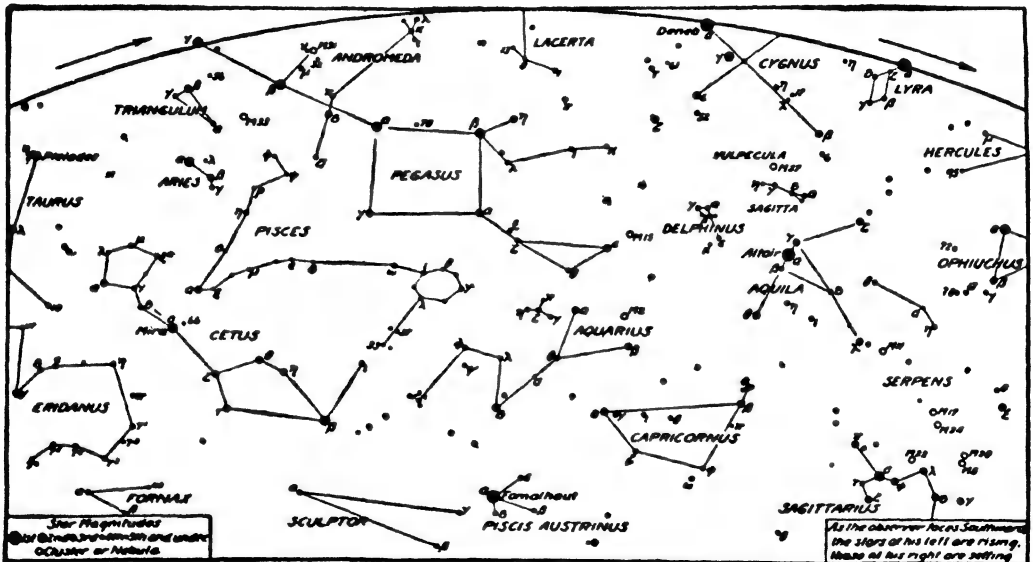
NIGHT-CHART 12



FACING SOUTH

NOV. 1, 8 P.M., OCT. 15, 9 P.M., OCT. 1, 10 P.M., SEPT. 15, 11 P.M., SEPT. 1, 12 P.M.

KEY-MAP 12



FACING SOUTH

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NOV. 1, 8 P.M., OCT. 15, 9 P.M., OCT. 1, 10 P.M., SEPT. 15, 11 P.M., SEPT. 1, 12 P.M.

IV

SOME OBJECTS TO OBSERVE,—CLASSIFIED BY CHARTS

HAVING become acquainted with some of the constellations and brighter stars, the beginner may advance a step, to a few items of more detailed recognition, before he needs a larger Star-Book. In this chapter a few "celestial objects" are selected from each map and chart for special study. Since the student of the skies may begin to learn the constellations at any time of the year, these suggestions, like the Star-Maps themselves, may be used in *any order;* they are simply supplements to the maps, one by one. The same object is therefore mentioned again and again in these notes, as it comes again and again to the sky, at different times of the year; and care is taken below to mention each one at *favorable* seasons for its observation. Every object here mentioned is catalogued and described in Chapter V, which thus becomes an index to these notes.

Suggestions are added here and there for the use of an opera-glass, but no one must think that the enjoyment of the stars *demands* any such help. The Greeks who named the Constellations, the Arabs who named the bright stars, the Egyptians who regulated their lives by the heavenly bodies, used only their own attentive eyes to study the sky. But if you have an opera-glass or field-glass at hand, it can *add* somewhat to the pleasure given through your "naked eye." It will help you,

sometimes, to trace the outline of a constellation; with it you can "separate" some double stars, and make sure of the location of certain nebulæ or clusters that your eye guesses at. You may study brilliant star-fields or follow the course from night to night of an errant comet; or watch the light of the sun creep from night to night across the face of the moon. The glass which has served at the theatre, or has caught for you just the necessary mark to identify a strange bird, will *increase* in the same way your pleasure in the stars.

CHART 1. The Milky Way (see p. 73) shows some of its richest sections in Cygnus and Cassiopeia. With an opera-glass we can see that it is made up of innumerable stars closely massed together. In Lyra the star marked ε just above the bright star Vega, can be seen as double. The cluster in Cancer, called Præsepe (the Manger) or the Beehive, can be recognized with the naked eye, on a very clear night, like a tiny patch of cloud; in an opera-glass it is definite and interesting. You should be able to see the little star marked ζ near Mizar, in the "Great Dipper." Its name is Alcor. If you find it first with an opera-glass, your naked eye will place it more easily. Notice the bluish-white color of the bright star Vega; and the deep red color of μ in Cepheus, a small star but worth finding. Herschel called it the "Garnet Star."

CHART 2. The clusters in Taurus, the Pleiades and the Hyades, are beautiful with or without an opera-glass. Test your eyes by drawing the

Pleiades just as you see them. To sweep with an opera-glass, however low its power, through Canis Major, Orion and Taurus, will bring rich returns of interest. By watching carefully from night to night, you may see something of the strange variations of brilliancy of Mira, the Wonderful, in Cetus. In the key-map it is represented as of second magnitude, as it is at its brightest; at such times you will easily find it as a red star, the brightest in that region of the sky; at other times it is so faint that you will not be able to find it at all. There are two pretty double stars for an opera-glass, θ and σ, near Aldebaran.

CHART 3. The region of the Milky Way in Perseus and Cassiopeia will reward study with an opera-glass. Observe specially the superb field of stars near α of Perseus, and the "sword-handle" of the hero, composed of the great double-cluster marked χ-*h* on our map. The existence of the Great Nebula in Andromeda may be discerned if you locate it carefully from the chart. The star *g*, near ζ, at the bend of the "Dipper's" handle, is a test of eye-sight. These two stars have names of their own, Mizar and Alcor. Look at the group which goes by the name of Coma Berenices (Berenice's Hair); with a field glass, and possibly without one, you will see a certain fitness in the name. Near by, the star in Canes Venatici marked *15* is an easy double for an opera-glass.

CHART 4. On a clear night, particularly if there be no moon, something may be seen of the Great

Nebula in Orion. The whole region of the star θ is a wonderful study. The cluster in Cancer marked Præsepe *may* be found with the naked eye; for the clusters, M 35, near the "feet" of Gemini, and M 4, in Canis Major, you will need a glass. The Pleiades and Hyades are in good position for seeing. Notice the different colors of the bright stars Sirius, Betelgeuze, Rigel, Aldebaran and Regulus. You will hardly see the faint stars of Puppis and Columba, unless you live as far south as Memphis.

CHART 5. The beautiful circlet of stars which form Corona (the Crown) is worth looking at. α has the name Gemma, the Jewel of the Crown. In the rich star-fields of the Milky Way, here stretching low from north to west, note especially the regions near α in Perseus, and near ε in Auriga. Toward the east are some easy double stars for an opera-glass: ν in the head of Draco, and δ, ζ, and ε in Lyra. Notice the bluish white color of Vega. You will often see it long before other stars appear in the evening. The three little stars near Capella are a help to quick identification. Capella means she-goat; the little stars are often called the Kids.

CHART 6. The region to the east of Leo contains the constellation Coma Berenices, "Berenice's Hair." On a clear and moonless night you can see with an opera-glass the shining strands which suggest the mythological story. The cluster of the Beehive (also called Præsepe, the Manger) is here well-placed for seeing. Run a line from Regulus to Pollux and you will find the cluster a little

below the line and about midway between them. The constellation Libra is uninteresting, but you may divide the double star α with your glass. The bright stars Pollux, Regulus and Spica, are sometimes outshone by one or even more of the planets, which pass near them in their "wandering" course. When a planet is in this region, make the most of your opportunity to fix its position in relation to bright fixed stars, and study its movement.

CHART 7. Follow the course of the Milky Way through Auriga, Perseus, Cassiopeia, and on through Cepheus, Cygnus and Sagitta. The innumerable stars which compose it are massed more thickly at some points than at others. Near γ in Cassiopeia and along the line of the cross in Cygnus, are regions of especial beauty. The star μ in Cepheus is interesting for its color. Herschel called it the "Garnet Star." Compare it with a white star like α in the same constellation. The little star marked δ near the foot of the Cross is a double for a field-glass. It is in the constellation Vulpecula, the Fox. Draco, the Dragon, is easy to trace in this position; in the head of Draco, the star ν is an easy double. The Constellation Ursa Major as shown in the key-maps lies on all three sides of the words of its name. The stars σ^1, σ^2 and ρ (supposed to be at the bear's ears) make an interesting field-glass group.

CHART 8. Follow with your eyes or glass the Scorpion's tail, from his heart at α or Antares through τ, ε, μ, and around to χ, λ and υ. If you

live far enough to the south you will see some stars in the outline which our charts can not include. This is a rich section of the Milky Way. The little star μ of Scorpius is double for a field-glass, but may be too near the horizon for observation. α in Libra is double, and well placed now. Do not fail to sweep through the fine scattered cluster of Coma Berenices, lying just above a line connecting the bright Arcturus with the star β in Leo,—whose name is Denebola. Four bright stars form a sort of "diamond" around the constellation Coma,—Arcturus, Spica, Denebola and *12* in Canes Venatici. The clusters, M 80, M 6, and M 7 will show their delicate glimmer in a field-glass if the horizon is clear.

CHART 9. Berenice's Hair shows its golden strands in the west on a clear night. The Milky Way is now almost perpendicular to the horizon, with specially beautiful regions near α of Perseus and in Cassiopeia. The double cluster, χ-*h*, is beautiful in an opera-glass; look also at ζ in Cepheus, *15* in Canes Venatici, and the little star *56* in Andromeda. On a clear night try for the Great Nebula, M 31; the key-map will help you to locate it. Algol in Perseus is a famous variable star. It will need close attention for a good many nights, for you to discern its variations. It is sometimes brighter and sometimes fainter than γ in the same constellation, and its "period" is about three days.

In this map note especially the distortion caused by representing the sky on a flat map. The "Square" of Pegasus and the kite-shaped figure

of Boötes come too near the edges of the map to be very like their actual forms in the sky.

CHART 10. Sweep the shining course of the Milky Way from Cygnus to Sagittarius. There are a large number of clusters in the region of Serpens, Sagittarius and Scorpio. On a clear moonless night try M 7, M 8, M 6, and M 22, with an opera-glass. They are not hard to find, if you place them in connection with the bright stars of the region. The chaplet of stars, a part of the Constellation Pisces, is interesting to trace, with the eye or glass; and so is the little Y in Aquarius which forms the mouth of the water jar. There are double stars for a field-glass in α of Capricornus; 6, near the foot of the northern Cross; and possibly β of Capricornus, but that may need a stronger glass. The Constellation Pegasus as it rises is divided between the northern and southern maps at this season. See what is said above about distortion.

CHART 11. The three little stars near Capella (the She-Goat) are often called "the kids." Auriga, the Charioteer, is carrying them all in his arms. The group is easily identified. Contrast the color of Capella with that of Aldebaran, just rising. Study with an opera-glass, if you can, the splendid star-fields of the Milky Way, running through Cygnus, Cepheus (near ζ), Cassiopeia, Perseus, and Auriga, to the stars in the "feet" of Gemini. The fine cluster M 35 is not far from it. In the

group of the Hyades, observe the stars marked θ and σ and in Draco the double star ν. All these objects require an opera-glass or field-glass. But the Pleiades, however beautiful with a glass, are always interesting to study with the naked eye. Try to draw the stars of the cluster as you see them, and find out how many you can detect. Estimate the size of the Moon compared to this cluster. The width of the full moon, as we see her in the sky, is less than the distance across the cluster.

CHART 12. The Milky Way is here at our right, toward the west. This is not so brilliant a portion of it as we see in some other parts of the sky. Delphinus, the Dolphin, and Sagitta, the Arrow, justify their names as constellations. The little Y in Aquarius, which forms the mouth of the Water-Jar, and the chaplet of stars just to the left of it, in the constellation Pisces, are interesting to trace with a glass or the naked eye. Among easy double stars for an opera-glass are α and β of Capricornus and the little star δ in Vulpecula near β of Cygnus. Mira, the red star in Cetus, was the first variable discovered. If you watch it carefully whenever it is in the sky, you may notice some change in its brightness. Although sometimes of the second magnitude, it is sometimes invisible to the naked eye.

Never forget that every star has its best times for observation, and select, especially at the beginning, the objects near the middle of each map.

V

SOME OBJECTS TO OBSERVE,—CLASSIFIED BY CONSTELLATIONS

The numbers of the maps in which each constellation is shown are given after the name of the constellation. The order need not be observed and is merely a suggestion.

When no translation follows the Latin name of a constellation it is a *proper* name. Any good dictionary of mythology will tell you the stories connected with the names.

The italics mark the names of the Zodiacal Constellations. It is important to remember that the presence of a planet "in" one of these constellations sometimes confuses the outlines, until the beginner has become familiar with them (see pp. 77 and 75). The Moon by her brilliancy is also a source of confusion, blotting out the stars in her neighborhood as she passes through these constellations.

The Greek Alphabet is given in full, although not all of its letters happen to occur in this list: α, Alpha; β, Beta; γ, Gamma; δ, Delta; ε, Epsilon; ζ, Zeta; η, Eta; θ, Theta; ι, Iota; κ, Kappa; λ, Lambda; μ, Mu; ν, Nu; ξ, Xi; ο, Omicron; π, Pi; ρ, Rho; σ, Sigma; τ, Tau; υ, Upsilon; φ, Phi; χ, Chi; ψ, Psi; ω, Omega.

An-drŏm′-e-da (Maps 9, 3, 12, 2). The Great Nebula in Andromeda, M 31, can be detected

by a good eye on a clear night. If you can first locate it with an opera-glass, the eye will find it more easily. It is the largest spiral nebula, and enormously distant.

A-quā'-ri-us, the Water-Carrier (Maps 12, 10, 2). This large constellation has no stars brighter than the third magnitude. The little Y of four small stars near α is supposed to mark the mouth of the Water-Jar. An opera-glass shows it very clearly.

Ă'-quĭl-a, the Eagle (Maps 10, 12, 8). Al-tair'. a first-magnitude star; yellowish white. See the directions for using the "Shaft of Altair" to find other stars, page 18.

Ā'-ries, the Ram (Maps 12, 2, 9, 4, 3). A small and faint constellation, which is nevertheless important because the planets may be seen "in" it.

Au-rĭ'-ga, the Charioteer (Maps 11, 5, 4, 2, 1). Ca-pel'-la, α of Auriga, a first-magnitude star easily identified by the little triangle of faint stars near by. Capella is Latin for she-goat, and the little stars are often called "the kids."

Bō-ō'-tes, the Herdsman (Maps 8, 6, 3, 5, 9, 10). One of the first recorded constellations. Arc-tū'-rus, one of the brightest of the first-magnitude stars, of a deep yellow color. The stars in the handle of the "Dipper," if we imagine the curve continued, point fairly near to Arcturus. You will learn to recognize

it as it rises by grouping it with the two stars, η and υ of the same constellation, which precede it through the sky.

Ca-mel-o-par'-dus, the Giraffe (Maps, all northern)

Can-cer, the Crab (Maps 4, 6, 1, 7), a faint constellation, hard to find at first, but interesting to recognize after you have learned it. Especially for the sake of Prae-se'-pe, the Manger, also called the Beehive; a beautiful cluster which your eye will learn to find on a clear and moonless night, and which is beautiful in an opera-glass. Galileo counted 36 stars with his first "telescope," which was what we should call a field-glass.

Cā'-nēs Ve-nāt'-i-cī, the Hunting Dogs (Maps all northern except 1 and 11; also 6 and 8). A modern constellation near the handle of the Great Dipper. *12*, the brightest star, which is α of the constellation, was named by Halley, Cor Caroli, the heart of Charles, in honor of Charles II of England. It has a distinguishing red color. (Read what is said below about Denebola, in Leo.) The star marked *15* is double. Your opera-glass will show it to you as *two* little stars.

Cā'-nis Mā'-jor, the Great (er) Dog (Maps 4, 2, 6). SĪ'-ri-us, the brightest star in the sky, 12 times as bright as Aldebaran in Taurus, is also the nearest star to be seen by the unaided eye, in northern latitudes. But its light takes 8.8

years to reach us! As Sirius is the leading star in the "Great Dog" it is sometimes called the "dog-star"; and the days from July 3d to August 11th, when Sirius rises (invisible to us in the Sun's light) at nearly the same time as the Sun, are called the "dog-days."
M 41, a cluster, is a good object for an opera-glass.

Cā'-nis Mī'-nor, the Lesser Dog (Maps 4, 2, 6). Prō'-cy-on, a first-magnitude star, whose name means "precursor of the dog," because it always goes before the Dog-Star, Sirius.

Cāp-ri-cor'-nus, the Sea-Goat (Maps 10, 12). α may appear as double even to your naked eye; an opera-glass will divide it clearly. β is also double, harder to divide than α, and may take a stronger glass. (A large telescope divides each of these two stars into three.)

Cas-si-o-pē'-ia (Maps, all northern); always an easy constellation to learn, because of its great W of nearly equally bright stars; they form Cassiopeia's Chair.

Cen-tau'-rus, the Centaur (Maps 6, 8), hardly visible in the latitudes for which our maps are made, but containing some very bright stars, beyond our sight, of which one is the nearest fixed star known to us.

Cē'-phe-us (Maps, all northern). μ was called the "Garnet" Star by Sir William Herschel. Compare its color with that of some white star, like α in the same constellation.

Cē′-tus, the Whale (Maps 12, 2).

Mī′-ra (o of Cetus) has its name, the Wonderful, because of its great changes in brightness. There are about 11 months between its maximum and minimum. It is sometimes of the second magnitude, and sometimes invisible except through a telescope.

Co-lum′-ba, the Dove (Maps 2, 4).

Cō′-ma Ber-e-nī′-ces, Berenice's Hair (Maps 6, 3, 8, 9). You will find this constellation wonderfully beautiful in an opera-glass, and will see why some old astronomer named it for the golden locks of Berenice. But he had no opera-glass and saw it with the naked eye, and you too may see the shining strands on a clear night.

Cō-rō′-na Bō-re-ăl′-is, the Northern Crown (Maps 5, 11). This group has an appropriate name. α is named Gemma, the Jewel of the Crown.

Cor′-vus, the Raven, or Crow (Maps 6, 8). See also pp. 14, 15.

Crā′-ter, the Cup (Maps 6, 4, 8).

Cyg′-nus, the Swan (Maps 1, 7, 10). A brilliant constellation lying in the Milky Way, and marked by the striking figure of the Northern Cross. (The Southern Cross, visible in far southern latitudes, does not make so clear a figure).

Den′-eb (or α) is a first-magnitude star. o is worth looking at in your opera-glass; you will find it has a neighbor star, too close to be shown on the map.

M 39 is a good opera-glass object. It lies on a line from β to γ continued about as far again.

Del-phĭ'-nus, the Dolphin (Maps 10, 12, 7). This little diamond-shaped figure goes by many names.

Drā'-co, the Dragon (Maps all northern); an interesting constellation to trace, from the head at γ, toward which the cross-beam of the northern Cross points, to the far-away tail at λ, near the Pointers in the "Dipper." α, which the Arabs call Thuban, was the Pole Star, 4000 years ago. Any good text book of astronomy will explain how this can be.

ν is a double-star which an opera-glass will divide.

E-rĭd'-a-nus, the River Po (Maps 2, 4); the key maps show how these stars may be likened to a winding river.

Gĕm'-i-ni, the Twins (Maps 4, 2, 6, 1). Many have been the legends, even among savage peoples, in which these stars have been identified with heroic pairs. Castor (α) and Pollux (β) are both first-magnitude stars; Pollux is the brighter, although to Castor is assigned the letter α.

M 35 is a fine star-cluster, visible in an opera-glass, and beautiful in a field-glass.

Her'-cu-les (Maps 8, 5, 10, 11); sometimes called the Kneeler, because in picturing the hero, as outlined by the brighter stars, he is sup-

posed to be kneeling, head at α, shoulders at β and δ, knees at ρ and η, etc.

Hȳ′-dra, the Water-Snake (Maps 6, 4, 8). α is sometimes called Cor Hydrae, the heart of the Water Snake; its Arabic name is Alphard, the Solitary.

La-cer′-ta, the Lizard (Maps all northern except 5 and 11).

Lē′-o, the Lion (Maps 4, 6, 8, 1, 7); easily distinguished by the figure of a sickle, formed by some of its stars, which is the first part of the constellation to rise. When a bright planet is "in" Leo, the combination is splendid, but confusing, until you are familiar with the constellation.

Regulus (α of Leo) is the faintest star which is counted as of first magnitude.

τ is a double which can be separated by a good field-glass. β, which has also the name Dĕ-neb′-o-la, is at one corner of a great "diamond," with Arcturus, Cor Caroli, and Spica at the other corners.

Lē′-o Mī′-nor, the Lesser Lion (Maps 1, 3, 4, 6, 7).

Lē′-pus, the Hare (Maps 2, 4). The faint star γ is rather far south for easy observation, but on clear nights in winter you may see it double in your opera-glass.

Lī′-bra, the Scales or Balances (Maps 8, 6, 10). There is no bright star in this constellation, but a planet sometimes shines within its limits α is an easy double-star for the opera-glass.

Lynx, the Lynx (Maps 1, 3, 7).

Lȳ′-ra, the Lyre (Maps 10, 11, 5, 7, 12); one of the easiest constellations to identify, because of the geometrical figures which its brighter stars suggest.

Vega, α of Lyra, a first-magnitude star, is easy to recognize in the early evening, when it is in the sky, even before its neighbor stars appear, by its brilliant, bluish-white color. ε is double for an opera-glass.

Mō-nŏ′-ce-ros, the Unicorn (Maps 4, 6). Not far from ε, nearly on a line from Procyon to Betelgeuze, is a particularly fine cluster for opera-glass or field-glass.

Ō-phi-ū′-chus, the Serpent-Bearer (Maps 8, 10). Look with an opera-glass at the field about ζ; you will find a group of little stars; they are of the 9th magnitude.

Ō-rī′-on (Maps 2, 4, 6). A large part of the mythology of the sky is connected with Orion, the Giant Hunter. See any Classical Dictionary. The stars of the constellation are almost all extremely remote, and yet astronomers have learned a great deal about their constitution, their temperature, their age, their size, their movements and their distances from us.

Bet′-el-geuze (α of Orion) has been specially studied. It is not the largest star of which we know, but its diameter is some 215 million miles. Contrast its red color with the bluish tint of Rī′-gel (β of the constellation). This is

one of the most distant of all the stars that we see.

The *Great Orion Nebula surrounds the star* θ. *On a clear night even an opera-glass may give* you some hint of its presence.

Pĕg'-a-sus (Maps 12, 2, 9, 3). The "Square of *Pegasus*" *rises in the north-east in the evenings of Autumn, when beginners are likely to be taking up the study of the constellations, and is* one of the easy groups to identify. One of its stars is a part of the neighbor constellation, Andromeda. Notice that its *shape* is better represented in the maps where it comes near the centre, than in those where it is near the border.

Per'-se-us (Maps 11, 9, 3, 5). The legend of the Greek Hero whose name is given to this constellation, includes the stories of Andromeda, Cassiopeia and Cepheus.

α lies directly in the Milky Way, and is the centre of a brilliant field of stars, for opera-glass or field-glass.

β is the famous variable star, called by the Arabs Algol. The Winking Demon is one of its names. By watching it, night after night, you may perhaps notice its changes (as the early Arabs did) without an instrument. There are nearly three days between two successive times of brightness.

The double cluster which is given the strange name χ-*h* is visible in an opera-glass.

Pis'-cēs, the Fishes (Maps 12, 2). The chaplet of stars formed by θ, γ, λ, etc. is pretty in an opera-glass; or, under good conditions, with the naked eye.

Pis'-cis Aus-trī'-nus, the Southern Fish (Map 12) has no connection with the other Fishes. It has one first-magnitude star, Fomalhaut (pronounced Fō'-mal-ō), which is a conspicuous object in the southern sky, during the early evenings of Autumn.

Sa-git'-ta, the Arrow (Maps 10, 12, 7) is a constellation whose name is appropriate.

Sa-git-ta'-ri-us, the Archer (Maps 10, 8, 12). Of the many clusters in this constellation, M 8 is visible to the naked eye, under good conditions. The others need telescopic help.

Scorp'-i-us, or *Scorp'-i-o*, the Scorpion (Maps 8, 10) really suggests the Scorpion of the tropics, if we are observing far enough to the south to be able to see it all. We may recognize the chief stars, even through the haze which so often lies near the horizon, by the fan-like figure of six bright stars.

An-tā'-res (α), the red, first-magnitude star, has its name as the "rival" of Ares or Mars, the red planet. The two may sometimes be seen near together in this zodiacal constellation Antares is also called, in several languages, "the Scorpion's heart." The diameter of the great and distant star is some 400 million of miles.

M 80 is an interesting object for a field-glass when the air is clear, but hardly likely to show as a cluster without a stronger glass.

M 6 and M 7 are very near the horizon at best, but on a clear night, you may see them as clusters even with the naked eye.

Ser'-pens, the Serpent (Maps 8 and 10). Look near β, especially toward the north-east, for a fine field of little stars, visible in opera-glass or field-glass.

Tau'-rus, the Bull (Maps 2, 4, 11, 5), always a splendid constellation, and at its most splendid when a "wandering" planet is seen among its stars. Al-dĕb'-a-ran (α) is a first-magnitude star. Compare its color with that of Capella and Rigel when they are all in the sky together. The Pleiades were named and loved by the Greeks as early as 800 B.C. The books of Amos and Job show that the Hebrews were interested in the group in very early times. It is still studied, and recent astronomers have counted over 2,000 stars in the cluster. With the naked eye, you should see six of them, "glittering like a swarm of fireflies tangled in a silver braid." The opera-glass will of course increase the number.

The Hȳ'-a-des; a cluster more widely spread than the Pleiades, beautiful and interesting. θ and σ are wide doubles, easily separated by an opera-glass. If the field of your glass is wide, you may see θ and σ at the same time.

Trī-an'-gu-lum, the Triangle (Maps 2, 12, 9, 11).

Ur'-sa Mā'-jor, the Great(er) Bear (Maps, all northern), recognizable always (though it does not look like a bear!) by the dipper-shaped figure of its chief stars. The constellation is circumpolar; i.e., it is always in the northern sky (see page 9) and the stars β and α—the Pointers—always point to the north pole of the heavens. Many names, such as Charles' Wain (or Wagon), the Plough, the Seven Yoke-Oxen, etc., have been given to the group which we often call the Big Dipper. Mizar (ζ) and Alcor (g) at the bend of the "Dipper's" handle will be seen as separate stars by a good eye. σ, σ² and ρ make a good opera-glass group.

Ur'-sa Mī'-nor, the Lesser (or Little) Bear (Maps, all northern) is another circumpolar constellation. That is, it never goes below the horizon in our latitudes. It is recognized by the figure of the "Little Dipper." After watching the northern sky for a series of evenings, you will see how appropriately the stars β and z might be called the "Guardians of the Pole."

Pō-lā'-ris, the Pole-Star, is not exactly at the Pole of the Heavens. Although it may seem to us to be always in the same place, it revolves in a small circle about the Pole; its small differences of position must be taken carefully into account by navigators.

Vir'-go, the Virgin (Maps 6 and 8), has represented

a maiden for untold centuries, among Greeks, Egyptians, Chaldeans, and even Chinese; but the figure is not clearly indicated.

Spica (α of Virgo), a first-magnitude star, is at one corner of a great "diamond" of stars, sometimes called the Diamond of Virgo, although only one of its four stars is in this constellation. The other three are Arcturus, in Boötes; Denebola, in Leo; and Cor Caroli, which is the red star, *12*, of Canes Venatici.

Vul-pĕc'-u-la, the Fox (Maps 12 and 7).

The little star, *6*, which is near the foot of the Northern Cross, belongs to this constellation. It makes a pretty opera-glass object with a neighbor star too small to be shown on our maps.

Names of Stars and Clusters included in this list, with the constellations in which they are mentioned:

Alcor, *Ursa Major;* Aldebaran, *Taurus;* Algol, *Perseus;* Alphard, *Hydra;* Altair, *Aquila;* Antares, *Scorpius;* Arcturus, *Boötes;* Beehive, *Cancer;* Betelgeuze, *Orion;* Capella, *Auriga;* Castor, *Gemini;* Cor Caroli, *Canes Venatici;* Dippers, *Ursa Major* and *Ursa Minor;* Deneb, *Cygnus;* Denebola, *Leo;* Fomalhaut, *Piscis Austrinus;* "Garnet" Star, *Cepheus;* Gemma, *Corona Borealis;* Hyades, *Taurus;* Manger, *Cancer;* Mira, *Cetus;* Mizar, *Ursa Major;* Pleiades, *Taurus;* Polaris, Pole star, *Ursa Minor;* Pollux, *Gemini;* Praesepe, *Cancer;* Procyon, *Canis Minor;* Regulus, *Leo;* Rigel, *Orion;* Sirius,

Canis Major; Spica, *Virgo;* Thuban, *Draco;* Vega, *Lyra.*

The Milky Way which is so often referred to in this chapter and the preceding one, is a luminous band, extending around the heavens. To the naked eye it appears "nebulous," but a telescope shows that it is formed of an immense number of stars, and even an opera-glass reveals its starry structure. Its brilliancy varies much from one region to another; in some sections it seems indefinite and hard to place, but through Perseus, Cassiopeia, Cygnus, Sagitta, Aquila, Sagittarius and Scorpius, there are splendid portions of it. You can see it best on moonless nights, and where city lights do not obscure the brightness of the stars. The scientific study of the Milky Way goes far to explain the structure of the universe. You will sometimes see the Milky Way called the Galaxy —a name derived from the Greek word for milk.

VI

NOTES ON THE MOON AND PLANETS

THE moon is our nearest neighbor; yet there may be much that we have not noticed in our careless looking at her, month after month. Does every one know why we have "new" moons, and "old" moons, and "full" moons, and eclipses? Those are easy questions to answer, though we may not have thought of them. You see the new moon some evening, just after sunset, and you see how the slender line of light on the moon's edge is turned toward the place of the Sun, although the Sun is out of sight. Watching for a few nights, you see the little crescent grow wider and wider, and at the same time the moon draws away from the Sun, setting later each evening; and if you notice her position among the stars, you see that she seems to move steadily eastward in the constellations, as they all appear to turn about us. In two weeks her face is round and full, and she rises as the Sun sets. You realize that she is now placed like a mirror reflecting back to us the Sun's light; while at "new moon," most of the light which fell on her from the Sun illuminated that part of her sphere which we could not see. You continue your nightly watching, and the round full moon loses her round-

ness; still rising later and later every night, she moves on nearer and nearer to the Sun until your only chance to see her is before sunrise in the morning. More and more sunlight falls on that face of the moon which is turned from us, until she draws so close to the Sun in the morning sky that even the slender sickle shows no longer. Then for a few nights and days we see no moon at all; and then again she appears in the early evening as a new moon, lit by the departed Sun. In those twenty-eight days she has gone once around the Earth (this is an approximate, not an exact, statement). We have seen her against a background of stars which has differed from night to night.

The constellations "in" which we have seen her make a broad band around the sky; this band is called the Zodiac and the constellations are the Zodiacal Constellations. You will need to know these constellations by sight and by name. And you are sure to enjoy watching the moon's progress "through" them; later in this chapter you will see that this knowledge helps in the study of the planets.

The Zodiacal Constellations are:

Aries, Taurus, Gemini, Cancer, Leo, Virgo, Libra, Scorpius, Sagittarius, Capricornus, Aquarius and Pisces. The translations are given in Chapter V where these names are all printed in special type.

The Earth, as you know, turns on her axis about 365 times while she is revolving in her orbit about the Sun, so every part of the Earth receives sunlight at some time. But the moon in going about the

Earth turns just once on her axis, keeping always the same face toward us. That is why the full moon always shows us the *same* bright and dark spots. It is easy to recognize some of these with the naked eye; easier still, of course, with an opera-glass or field-glass. As the division line between light and darkness creeps across her face, you may see the tops of the high mountains catch the light before it shines into the valleys and lights up the plains.

As you watch the old moon approach the Sun's place, and later on see the new moon upon the other side of the Sun, you know she must have come nearly into line with the Sun and the Earth. Sometimes she comes quite into line, and her dark body shuts off some or all of the Sun's face,—then we have a *solar* eclipse. At full moon, also, when the Earth is between the moon and the Sun, the three bodies may come into line or nearly so, and then the Earth's shadow will fall on the moon and blot her out for a while; in that case we have a *lunar* eclipse.

More often the moon makes her revolutions without coming into line with the Sun and the Earth. The Almanacs tell you when to watch for eclipses. There are several in every year, but most of them will be "partial" eclipses, in which the Earth's shadow does not quite cover the moon, or the moon does not quite shut off the Sun from our sight; and not all will be visible at any one place on the Earth.

THE POSITIONS OF THE PLANETS FOR TEN YEARS BY CONSTELLATIONS

THE POSITIONS OF THE PLANETS FOR TEN YEARS

By Constellations

Aqr = Aquarius; **Ari** = Aries; **Cnc** = Cancer; **Cap** = Capricornus; **Gem** = Gemini; **Lib** = Libra; **Psc** = Pisces; **Sgr** = Sagittarius; **Sco** = Scorpius; **Tau** = Taurus; **Vir** = Virgo. When two constellations are named, the planet is either moving from one to the other, or is near the boundary between them.

Year	Planet	Jan.	Feb.	Mar	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1934	Venus	Cap Aqr	Cap Aqr	Cap Aqr	Aqr	Psc	Ari	Tau	Gem Cnc	Leo	Vir	Lib	Sgr
	Mars	Cap	Aqr	Psc	Psc	Ari	Tau	Tau Gem	Gem	Cnc	Leo	Leo	Vir
	Jupiter	Vir	Vir	Vir	Vir	Vir	Vir	Vir	Vir	Vir	Vir	Lib	Lib
	Saturn	Cap	Cap	Cap	Aqr	Aqr	Aqr	Aqr	Cap	Cap	Cap	Cap	Cap
1935	Venus	Cap	Aqr	Psc	Tau	Gem	Cnc	Leo	Leo	Leo	Leo	Vir	Lib
	Mars	Vir	Vir	Vir	Vir	Vir	Vir	Vir	Lib	Sco	Sco Sgr	Sgr	Cap
	Jupiter	Lib	Lib	Lib	Lib	Lib	Lib	Lib	Lib	Lib	Lib	Sco	Sco
	Saturn	Cap	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr
1936	Venus	Sgr	Sgr	Cap Aqr	Psc	Ari	Tau	Gem Cnc	Leo	Vir	Lib	Sgr	Cap
	Mars	Aqr	Psc	Psc	Ari	Tau	Tau	Gem	Cnc	Leo	Leo	Vir	Vir
	Jupiter	Sco Sgr	Sco Sgr	Sco Sgr	Sco Sgr	Sco Sgr	Sco Sgr	Sco Sgr	Sco Sgr	Sco Sgr	Sco Sgr	Sgr	Sgr
	Saturn	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr	Aqr
1937	Venus	Aqr	Psc	Ari	Ari	Psc	Ari	Tau	Gem	Leo	Vir	Vir	Sco Sgr
	Mars	Vir	Lib	Lib	Sco	Lib	Vir	Lib	Sco	Sco Sgr	Sgr	Cap	Cap Aqr
	Jupiter	Sgr	Sgr	Sgr	Sgr	Sgr	Sgr	Sgr	Sgr	Sgr	Sgr	Sgr	Cap
	Saturn	Aqr	Aqr	Aqr	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc

Year	Planet	Jan.	Feb.	Mar.	Apr	May	June	July	Aug	Sept.	Oct.	Nov.	Dec
1938	Venus	Sgr	Cap Aqr	Psc	Ari	Tau	Gem Cnc	Leo	Vir	Vir Lib	Sco	Sco	Lib
	Mars	Aqr	Psc	Ari	Tau	Tau	Gem	Gem Cnc	Cnc	Leo	Leo Vir	Vir	Vir
	Jupiter	Cap	Cap	Cap	Cap Aqr	Aqr	Aqr	Aqr	Aqr	Cap Aqr	Cap	Cap	Aqr
	Saturn	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc
1939	Venus	Sco Sgr	Sgr	Cap	Aqr	Psc	Tau	Gem	Cnc	Leo Vir	Vir	Sco Sgr	Sgr
	Mars	Lib	Sco Sgr	Sgr	Sgr	Sgr	Cap	Sgr	Sgr	Sgr	Cap	Aqr	Aqr
	Jupiter	Aqr	Aqr	Aqr	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc
	Saturn	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc	Psc
1940	Venus	Cap Aqr	Psc	Ari	Tau	Gem	Gem	Tau Gem	Gem	Cnc	Leo	Vir	Lib
	Mars	Psc	Ari	Ari	Tau	Tau	Gem	Cnc	Leo	Leo	Vir	Vir	Lib
	Jupiter	Psc	Psc	Psc	Psc	Ari	Ari	Ari	Ari	Ari	Ari	Ari	Ari
	Saturn	Psc	Psc	Psc	Psc	Ari	Ari	Ari	Ari	Ari	Ari	Ari	Ari
1941	Venus	Sgr	Cap	Aqr	Psc	Tau	Gem	Cnc	Leo Vir	Vir	Sco	Sgr	Cap
	Mars	Sco Sgr	Sgr	Sgr	Cap	Aqr	Aqr	Psc	Psc	Psc	Psc	Psc	Psc
	Jupiter	Ari	Ari	Ari	Ari	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau
	Saturn	Ari	Ari	Ari	Ari	Ari	Ari	Tau	Tau	Tau	Tau	Tau	Ari
1942	Venus	Cap Aqr	Cap Aqr	Cap Aqr	Aqr	Psc	Ari	Tau	Gem Cnc	Leo	Vir	Lib	Sgr
	Mars	Ari	Ari	Tau	Tau	Gem	Cnc	Leo	Leo	Vir	Vir	Lib	Lib
	Jupiter	Tau	Tau	Tau	Tau	Tau	Gem	Gem	Gem	Gem	Gem	Gem	Gem
	Saturn	Ari	Ari	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau
1943	Venus	Cap	Aqr	Psc	Tau	Gem	Cnc	Leo	Leo	Leo	Leo	Vir	Lib
	Mars	Sco Sgr	Sgr	Cap	Aqr	Aqr	Psc	Ari	Tau	Tau	Tau	Tau	Tau
	Jupiter	Gem	Gem	Gem	Gem	Gem	Cnc	Cnc	Cnc	Leo	Leo	Leo	Leo
	Saturn	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau	Tau

Sometimes a newspaper will speak of a coming "occultation," which its readers are to watch for. This is the "hiding" of a star or a planet by the moon, as she moves along her path through the Zodiacal Constellations. It is always well worth observing.

The word planet comes from a Greek word meaning "wanderer," for the planets have not fixed places among the stars. They belong to the family of the Sun, and as they move (like the Earth) about him, they draw sometimes nearer to us, and are at their brightest in the sky; or are removed so far, at the other side of their orbits, that they seem to lose their glory. Their background changes as they move, and we see them against first one and then another of the constellations. These are the Zodiacal Constellations, and are the same ones through which the moon appears to take her course. They form the background also for the Sun, as we on the Earth move about him in our orbit, but of course we never see the stars of a constellation while the Sun is "in" it (see page 41). When we say that a planet is "in" a certain constellation, that is a short way of saying that at that time, we see the planet against the distant background of the constellation mentioned. No planet can ever appear except "in" a Zodiacal Constellation.

The Tables preceding show the position of four of the planets in the constellations for a series of

years, month by month. Only Venus, Mars, Jupiter and Saturn are included in the list. Of the other planets, Mercury is so near the Sun that it is very difficult to see, being generally lost in the brilliancy of the Sun; two "outer" planets, Neptune and Uranus, farther from the Sun than Saturn, are not visible to the naked eye, nor even in a field-glass. But the four in the Tables may be followed by a beginner as they take their "wandering" course.

You may see a bright object in one of the Zodiacal Constellations which does not appear in that constellation on the maps. You feel sure that it is a planet, and wonder which one. Find in the Planet Tables, one by one, the date of your observing, by year and month; and in one of them, for just that time, you will find the name of the constellation in question and will learn what your stranger is. Or, we may wish to learn whether a certain planet is in our sky on a certain evening. First find from the Tables, the constellation in which the planet is to be looked for at that date. The list of constellations in Chapter V tells which maps show that constellation; and the time-tables below the maps show *when* the constellation is visible. On this occasion the wandering planet may even help you to locate some fixed stars.

You will see from the Tables, as you would gradually learn from observation, that the place of Venus in the sky changes quite rapidly; that of Mars, more slowly; while Jupiter may be in the same

constellation for many months at a time, and Saturn may even take years to pass through one of the larger constellations. For Venus is still nearer to the Sun than we are, and by watching only a few months, we may see her swing from one side of her orbit to the other; while Mars, Jupiter and Saturn, being farther from the Sun than the Earth is, complete their courses more slowly.

It is easy then to see that Venus can never be very far from the Sun in the sky; we shall see her either as evening star, just after sunset, or as morning star, shortly before sunrise, except at those times when she is so nearly in line with the Sun as she moves that she is lost for us in the Sun's light. Her motions are of unfailing interest to a beginner; compare her position from night to night with that of the bright stars in her neighborhood and see how it changes. Notice too how her brightness varies. With no glass at all you may see how her brilliancy fades when she is far from us in her orbit, and how she regains it as she comes nearer. At her brightest she is twelve times as bright as Sirius (see p. 62), and at such seasons, if you have a strong field-glass, you will see that all that brilliancy comes from a "crescent" Venus lighted like the crescent moon on the edge next the Sun. When she is on the farther side of her orbit and so placed as to reflect the Sun's light like a *full* moon, she is so far away as to appear much smaller, and therefore shows less bright.

As Mars is farther from the Sun than our Earth,

he can never show a crescent phase. But his apparent movements are most interesting to watch; it is worth while to make a diagram of the stars among which he appears and plot his course from night to night, or from week to week, for a few months. You will find Mars easy to recognize by his red color, and by the steady light which in clear weather usually distinguishes a planet from a fixed star. Mars varies in brightness more than Venus does. When nearest the Earth he is so much brighter than even the brightest stars in the zodiacal constellations, that you will recognize him at a glance; but when his motion and that of the Earth, in their orbits, carry them far apart, Mars appears only about as bright, for instance, as Castor; and you will have to know well the stars in the zodiacal constellations "in" which he happens to be, to recognize the wanderer.

Jupiter, the Giant planet, has four moons visible in a strong field-glass. If you have such a glass, watch them, on a clear night, at intervals of a few hours, and you may see changes in their positions as they revolve in their orbits. Sometimes you will see two on each side of the planet, or they may be differently placed; and there may be only two or three of them to be seen; in that case, wait, and the missing member will emerge from behind the planet, or from the bright light of the disk against which it has been invisible. But if you have no glass strong enough to show you Jupiter's moons, do not think him uninteresting. He far outshines

the great star Sirius, and is a splendid object to watch as he moves on his course.

Saturn changes his position so slowly among the stars that, having identified him from the planet Tables, you will find him for a long while in the same constellation and hardly seeming to be a wanderer at all. But in a clear atmosphere, you will see that he has a yellowish untwinkling disk; and you will find pleasure in checking his position from night to night by comparison with bright stars nearby, until you are sure that you detect a change. The wonderful rings of Saturn are not to be seen by a naked eye, nor even with an opera-glass, but the possessor of even a small telescope, or one who can obtain a glimpse through the instrument of some kindly observer, is likely to find Saturn and his rings the most interesting of all telescopic sights. Galileo, whose newly invented glass showed him that Venus had "phases," like our moon, and that Jupiter had moons of his own, could see some strange interruption of the roundness of Saturn's disk, but his largest instrument could not explain it to him.

Do not be surprised that there are seasons when no planet at all is visible in the evening sky. Sometimes they all happen to be in such regions of their orbits that they are above our horizon only during the day, lost in the light of the Sun; and one of the beginner's greatest joys is recognizing and welcoming one of the wandering family of the Sun as its light shines forth again in evening darkness.

For great as is the pleasure of becoming acquainted with the stars and planets, greater still, I think, is the joy of recognizing them as friends returning after absence: a star which nights of cloud have hidden shines in its place again; a constellation which has been over our heads by day and lost in sunlight, is distinguished again some evening, as the Sun moves on in his yearly course; or a gleaming planet, swinging in its orbit and lost for a while from our night sky, takes its place again as "morning star" or as "evening star," and we hail it by its name.

"Your landscape here upon our earth may change with each mile of your journeyings. Your skies, however, will remain. Whether in San Francisco or New York, whether in London or Florence, the same skies, approximately, will arch themselves over you, and spread above you 'the loved familiar roof of home.' They will unite you with past ages and older cultures, whether Biblical, Oriental, Greek, or Roman, just as they unite you to the lands of the present. And while they touch the larger emotions and open broader horizons to the mind, the imagination to which they speak springs from the evidences of precision and exactitude, from the sense of method and the bracing consciousness of law. It is a wholesome world in which to think and dwell."